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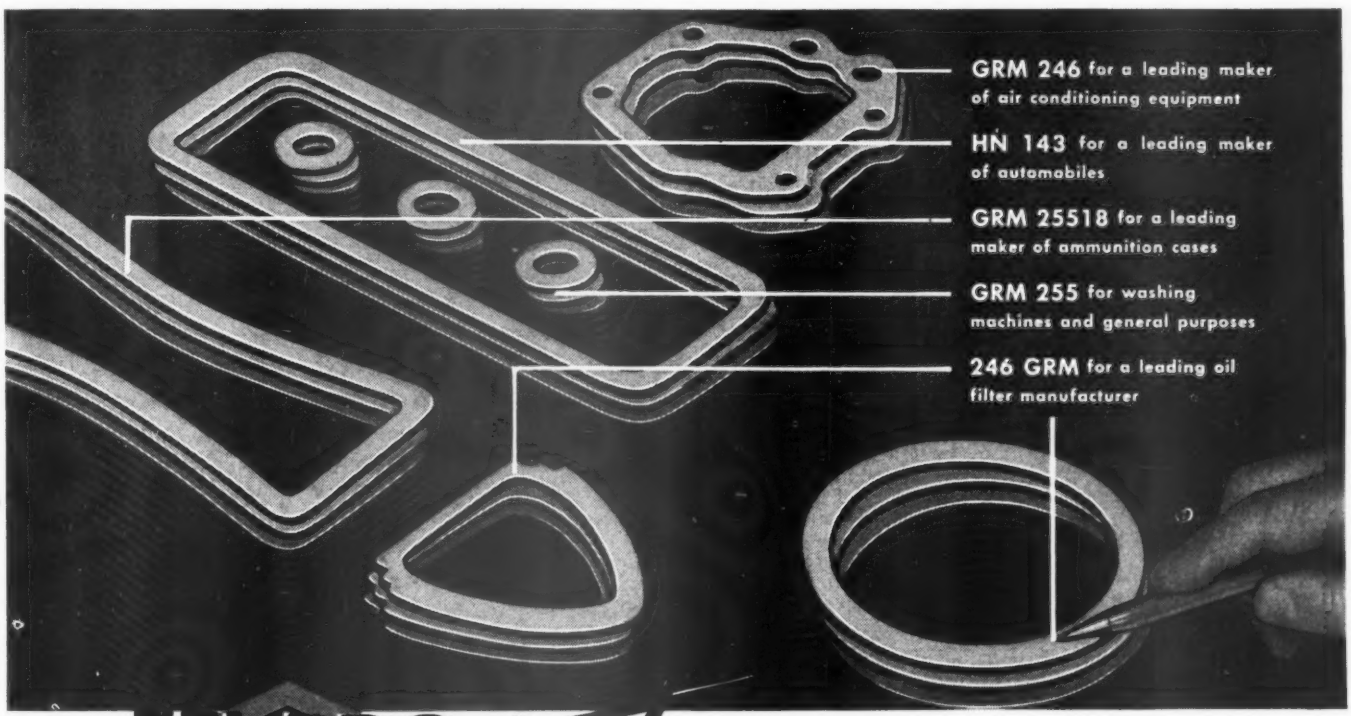
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The Course of Oil

by K. C. SCLATER

SANE STATEMENT ON RESOURCES

A sane statement on the much discussed question concerning the adequacy of our domestic hydrocarbon resources is that made by J. Edgar Pew before the Senate Special Committee Investigating Petroleum Resources of the United States. It merits the attention of those seeking enlightenment and background data on this entire question. Excerpts from this statement are presented here because of the refreshing viewpoint expressed by Mr. Pew, who speaks from more than half a century's experience.

"Any statement of crude oil reserves that is not based on 'known proved reserves' is unacceptable to me.

"This country possesses hydrocarbon resources sufficient to meet this Nation's requirements for oil products for generations to come, provided that adequate incentives for the exploration and development of these resources are permitted free of unnecessary restrictions.

"I have found no substantiation for recent contentions that a latent weakness has been disclosed in our domestic oil resource, that we are threatened with a rapid exhaustion of this resource, that in the very near future we shall be dependent upon foreign sources for oil. Certainly the widespread assertion that at current rates of consumption we are only about fourteen years away from an oil famine is based on a misunderstanding of the facts.

"None of these contentions is supported by an objective review of all the facts, soundly appraised in proper perspective. On the contrary, these facts and the historic trends of the American petroleum industry demonstrate that, except for brief transitory periods of readjustment to sudden changing economic and political circumstances, such as result from war, the American petroleum industry always has met the essential oil demands of this country and will continue to do so unless fettered by restrictions.

"The extent of American oil resources seems to be a very much misunderstood subject. This misunderstanding, in large part, grows out of mistaken or a loose use of terms and a comparison of non-comparable elements. Unfortunately some statements made in the last several years on this subject have been based on a ritualistic mumbo jumbo signifying nothing, except statistical legerdemain. They have created more confusion than enlightenment.

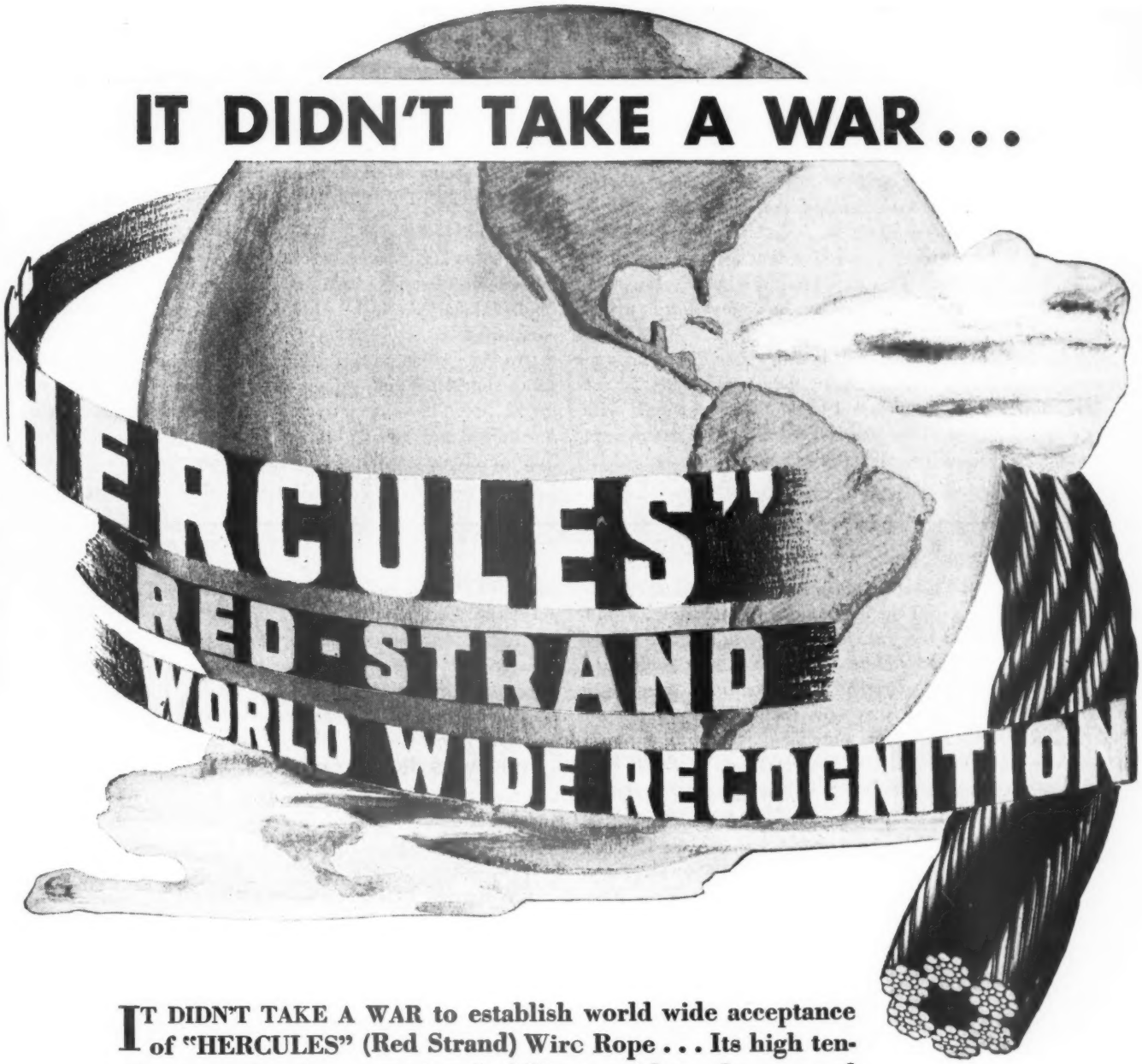
"One of the apparently most misunderstood terms in relation to this subject is that of 'Estimated Proved Reserves' which the Committee on Petroleum Reserves of the American Petroleum Institute has reported amounts to 20,453,231,000 barrels of crude oil as of December 31, 1944. Too frequently the term 'Estimated Proved Reserves' is taken to mean the total oil resources of the nation. Thus the current annual production is divided into this figure and the silly statement is made that, accordingly, we have only from twelve to fourteen years of oil left.

"Actually the 'Estimated Proved Reserves' is but a fraction of the country's total oil resources, even though that fact, except in regard to synthetic products, cannot be established with statistical precision. 'Estimated Proved Reserves', far from representing the total resources, constitutes but a stockpile underground for the petroleum industry. In recent years this stockpile has been from twelve to fifteen times greater than annual current production. What other industry, it may be appropriately asked, maintains a stockpile equivalent to approximately fifteen years of peacetime production and equivalent to twelve years of the abnormally high production of the last year of severe war demand?

"Pessimistic predictions regarding the adequacy of petroleum resources have been made periodically since the discovery of the Drake Well in 1859. All of these predictions have been proved by time to be erroneous. Current alarms to the effect that our petroleum supplies are nearing exhaustion are similar in both content and phraseology, to predictions made during and immediately after World War I. Neither then nor now has any substantial evidence been developed demonstrating any weakness in the ability of the American petroleum industry to meet demands for oil products.

"American supremacy in the finding of oil does not come from any peculiar genius on the part of our people. Rather, it results from our system of enterprise and opportunity which provides incentives that spur the initiative and ingenuity of Americans to search for oil. By and large, Americans have been free to drill wells wherever they thought oil might be found; they have been free and have had incentives to develop and produce the oil they discovered. Destroy these freedoms and incentives and you kill the spirit that has been responsible for our achievements in this field. Keep alive opportunities for individual initiative and assure that the reward for success in the search for oil is commensurate to the risk that is involved, and you can be certain Americans will develop within this country all the hydrocarbon products that our people need, in peace or in war. Of that I am as sure as I am that the sun shall rise and set tomorrow."

IT DIDN'T TAKE A WAR...



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Scanning WASHINGTON'S OIL HORIZON

WASHINGTON.—There is less likelihood now of the Big Inch pipe lines being used for gas transmission—and it isn't entirely because of opposition from railroad and coal interests.

Military authorities have decided that these lines will be vitally needed as oil carriers in event of another national emergency. But they take the position that maintenance of the lines in an inoperative status would be prohibitively expensive. Instead, they urge that these facilities be disposed of to private industry.

Oil use must be what they had in mind. Use of the lines for gas would build up a demand among industrial plants and consumers that couldn't be switched to another fuel supply without great difficulties. Thus, conversion back to oil use in event of another war would be virtually impossible.

So, if the military's views are adopted by the government, it can be expected that every inducement will be offered to continue the lines as oil carriers. If there are still no takers, the question boils down to: Will the government itself operate the lines?

This might fit in with Secretary Ickes' idea of storing foreign oil in oil fields, if he decides to go ahead with it. Big Inch could be reversed, carrying imported crude westward from New York and Philadelphia to the Appalachian oil regions or even to the southwest.

Another angle is this: Within Interior Department, it has been suggested that—to preserve our own resources—oil imports should be stepped up and every domestic refiner required to process a certain percentage of this imported crude. So, the big pipe lines may figure in this scheme, too.

● **AERIAL DOODLEBUG.** Officials of Naval Ordnance Laboratory, which developed the air-borne magnetometer for military purposes during the war, hope to get this device off the restricted list so they can present a paper on it before one of the technical meetings next year. They might be ready to spring it at the AIME meeting but, they said, the April meeting of the American Geophysical Union is more likely. (General outline of how the air-borne magnetometer has been used in geophysical work in secret tests was disclosed in this space last month.) Navy officials, however, may be underestimating pressure being brought to get this device released sooner than next spring.

● **STRIPPER WELLS.** Interior Department is developing a program for continued production from stripper wells, conserving the large reserves underlying these marginal wells. Meanwhile, the wartime stripper well subsidy is likely to be retained until Interior's program is worked up, which may be several months.

● **ICKES AND TIDELANDS.** Secretary Ickes apparently has stymied action on the Sumners-McCarran Resolution declaring state ownership of submerged lands. Passed by the House, hearings on the resolution were scheduled for December 3-4 but have now been postponed "until some time after January 1st."

Ickes first clouded the issue by persuading President Truman to proclaim federal ownership of the Continental Shelf. Next, with Truman's help, he persuaded Attorney General Tom Clark to file a Supreme Court suit against California to test the submerged lands issue.

Now, he can argue that Congress should defer action until the high court acts, then legislate on the whole submerged lands issue, including the Continental Shelf.

All this is further evidence that Ickes stands in well at the White House, momentarily anyway.

● **OPA.** Continuance of oil price controls well into 1946 is virtually certain now under President Truman's wage-price policy, which invites workers to seek pay increases but delays for six months even an application for price advances to offset increased labor costs.

But it is possible that ceilings on some products may be suspended as supply becomes adequate to meet all demands. However, OPA will hang on to the controls, ready to put them back when and if it seems necessary.

● **DEPLETION ALLOWANCE.** When the Treasury Department's new tax program is sent to Congress early next year, it may suggest an entirely new approach to taxation of extractive industries, including oil and gas production. Believing that the percentage depletion allowance is "entirely wrong in principle," some high-ranking Treasury officials would not be satisfied with recommending merely a reduction in present rates.

● **POSTWAR ORGANIZATION.** Oil men are still debating how to organize a postwar version of the Petroleum Industry War Council that could preserve the industrial unity prevailing during the war period.

Some believe this is just as simple as dropping the word "war" from the PIWC title and limiting the new organization's activities to matters that do not conflict with anti-trust laws.

Others, however, believe that it would be safer to have an executive order or legislation clearly spelling out the organization's functions.

Such an overall organization as the PIWC would be representative of all elements of the industry. It could tie together advisory groups set up by federal agencies, by the Interstate Oil Compact Commission and the International Oil Commission to be established under the Anglo-American Oil Agreement.

● **UNITIZATION TAX.** Oil men here regard Internal Revenue Bureau's efforts to tax unitized field committees as another move to cut down the supposed tax advantages of oil companies, since IRB so far has been unsuccessful in eliminating the depletion allowance. (An earlier instance of this was the F.H.E. Oil Company case, involving an attack on the intangible drilling cost option.) IRB Agent Wilde at Dallas has attempted to tax as a "corporation" the East Alice Operating Committee, resulting in more than a score of petitions from operators being filed with the U. S. Tax Court here.

● **NOTES.** Surplus Property Administration's report to Congress on disposal of government-owned 100-octane is being written by Elmer Batzell, Ex-PAW lawyer.... Army wants federal gasoline specifications tightened up, with narrower boiling range and stricter sulphur tolerance..... Several gas companies have shown interest in acquiring the Southwest Emergency Pipe-line.... Oil men's hopes are fading that any congressional group will take a postwar stand for levying income taxes on co-operatives.

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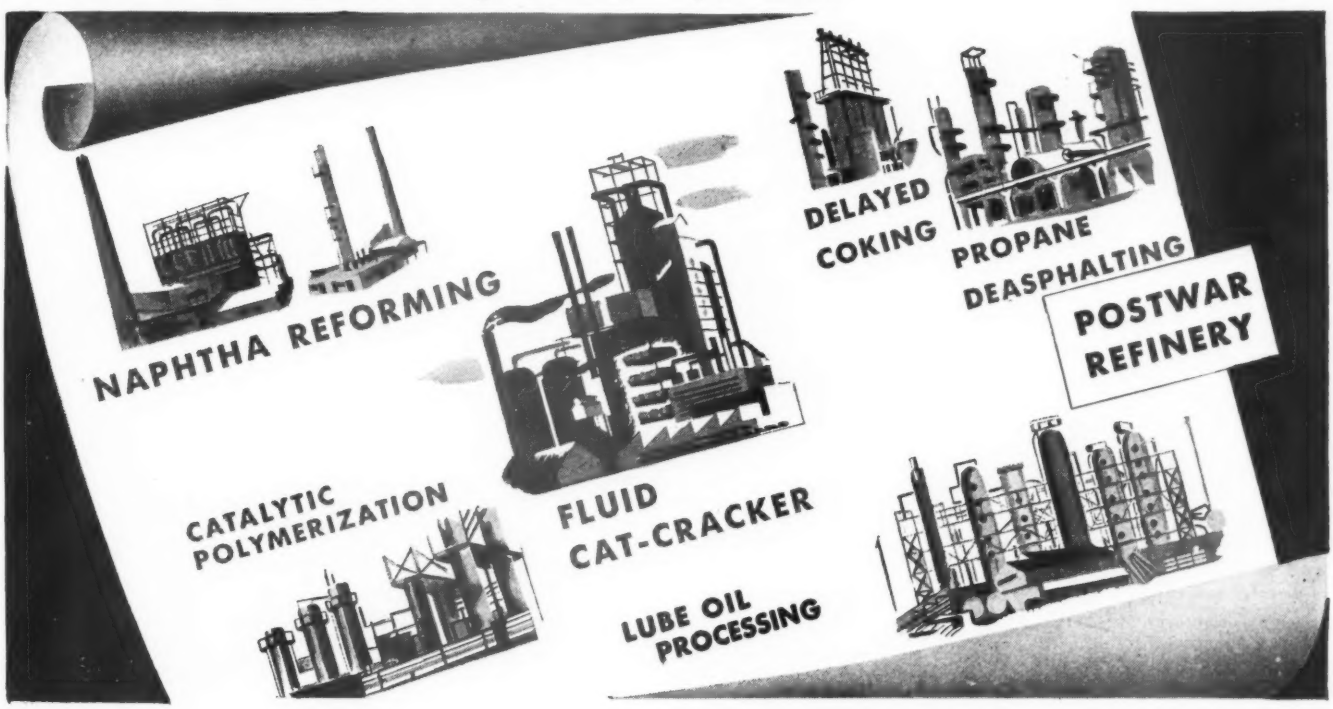

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NATIONAL PETROLEUM SITUATION

POSTWAR CURTAILMENT. Crude oil production in October was about 945,000 barrels a day less than the peak established in July. Daily output is estimated at 3,999,000 barrels, against 4,467,000 in September and 4,944,000 barrels in mid-July. Production for 10 months is 3 per cent above last year, but October output was 16 per cent under a year ago.

DEMAND OFF MILLION BARRELS. October crude oil demand was over 1,000,000 barrels below the rate reported by the Bureau of Mines for August. October demand is estimated at 4,121,000 barrels daily, against 5,151,000 barrels daily in August. This confirms earlier predictions of a postwar decline of at least 1,000,000 barrels daily.

LESS DRILLING. Well completions in October are shown to have declined about 6 per cent under September. Completions were 2,286 against 2,423 in September. New wells drilling November 1, were also reduced. Total wells drilled in 10 months ending October were within the quota prescribed for this period. Cumulative completions were 22,368, against a quota to date of 22,496.

EXPLORATION LAGGING. Wildcat completions in October were 23 wells above a year ago, but results for the first 10 months of the year are about 18 per cent below the prescribed quota. Wildcats drilled to date total 3,444, against a quota of 4,165. With only 2 months to the end of the year, the quota of 5,000 wildcats will fall short by about 820 wells.

GASOLINE DEMAND OFF. Demand for motor fuel in October was about 7 per cent under September. Reduction in military demand was of substantial proportions, but was partially offset by increased civilian use. October demand was nearly 2 per cent above a year ago. In the first 10 months of the year, which reflects war demand, gasoline consumption was about 11 per cent above last year.

FUEL OIL DEMAND GREATER. Demand for fuel oil in October was nearly 7 per cent above September, but was slightly lower than a year ago. The cumulative demand was about 4 per cent ahead of last year.

PRODUCTION EXCEEDS NEED. Cumulative crude production through October is shown to have been about 17,000 barrels a day above actual requirements. Demand was about 4,888,000 barrels daily, of which 200,000 were supplied by imports. This called for a domestic production rate of 4,688,000 barrels. Actual output was 4,705,000 barrels.

Comparative Statistics, October, 1945

*All figures are computed on a Bureau of Mines basis**

	October 1945	Sept. 1945	October 1944	This year to date	Last year to date	Per cent change
Wells drilling	4,130	¶4,200	4,200	4,130	4,200	— 2
Total wells drilled	2,286	2,423	2,102	22,368	18,164	+23
Development wells	1,918	2,057	1,757	18,924	14,998	+26
Oil	1,134	1,248	1,205	11,531	10,378	+11
Gas	241	239	197	2,110	1,758	+20
Dry	543	570	355	5,283	2,862	+85
Per cent dry	28.3	27.7	20.2	27.9	19.1	+ 8.8
Wildcat wells	368	366	345	3,444	3,166	+ 9
Oil	48	53	47	459	391	+17
Gas	7	12	13	113	104	+ 9
Dry	313	301	285	2,872	2,671	+ 8
Per cent dry	85.0	82.2	82.6	83.4	84.4	— 1.0
Crude production	123,980	134,010	146,938	1,430,363	1,390,067	+ 3
Daily average	3,999	4,467	4,740	4,705	4,558	
Crude demand†	127,755	132,600	151,778	1,486,069	1,446,800	+ 3
Daily average	4,121	4,420	4,896	4,888	4,744	
Crude stocks	226,900	224,940	229,987	226,900	229,987	— 1
Days supply	55	51	47	55	47	
Natural gasoline production	8,020	8,360	9,090	91,433	84,225	+ 9
Daily average	259	279	293	301	276	
Motor fuel production	61,690	62,890	65,514	670,027	612,842	+ 9
Daily average	1,990	2,096	2,113	2,204	2,009	
Gasoline yield, per cent	42.0	42.9	40.1	41.1	39.1	+ 2.0
Motor fuel demand	65,660	68,250	64,523	680,646	613,885	+11
Daily average	2,118	2,275	2,081	2,239	2,013	
Motor fuel stocks	68,450	72,220	70,046	68,450	70,046	— 2
Days supply	32	32	34	32	34	
Fuel oil production	54,830	53,560	61,019	600,572	582,031	+ 3
Daily average	1,769	1,785	1,968	1,976	1,908	
Fuel oil demand	60,300	54,750	60,712	654,992	629,267	+ 4
Daily average	1,945	1,825	1,958	2,155	2,063	
Fuel oil stocks	85,120	85,975	104,772	85,120	104,772	—19
Days supply	44	47	54	44	54	
Refinery still runs	130,070	129,990	143,720	1,439,307	1,380,514	+ 4
Daily average	4,196	4,333	4,636	4,735	4,526	
All refined stocks	227,280	235,560	255,824	227,280	255,824	—11
Days supply	46	47	52	46	52	

*Unless otherwise stated all figures represent thousands of barrels.
†Domestic and foreign. ¶Revised.

Economic Position of U. S. Petroleum Industry

Ten months ending October 31, 1945

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	22,496	22,368	99.4
Production (daily crude output)	4,688	4,705	100.4
Refining (daily still runs)	4,873	4,735	97.2
Stocks (crude and refined)	474,750	454,180	95.7
Price of crude (per barrel)	$1.98	$1.22	61.6

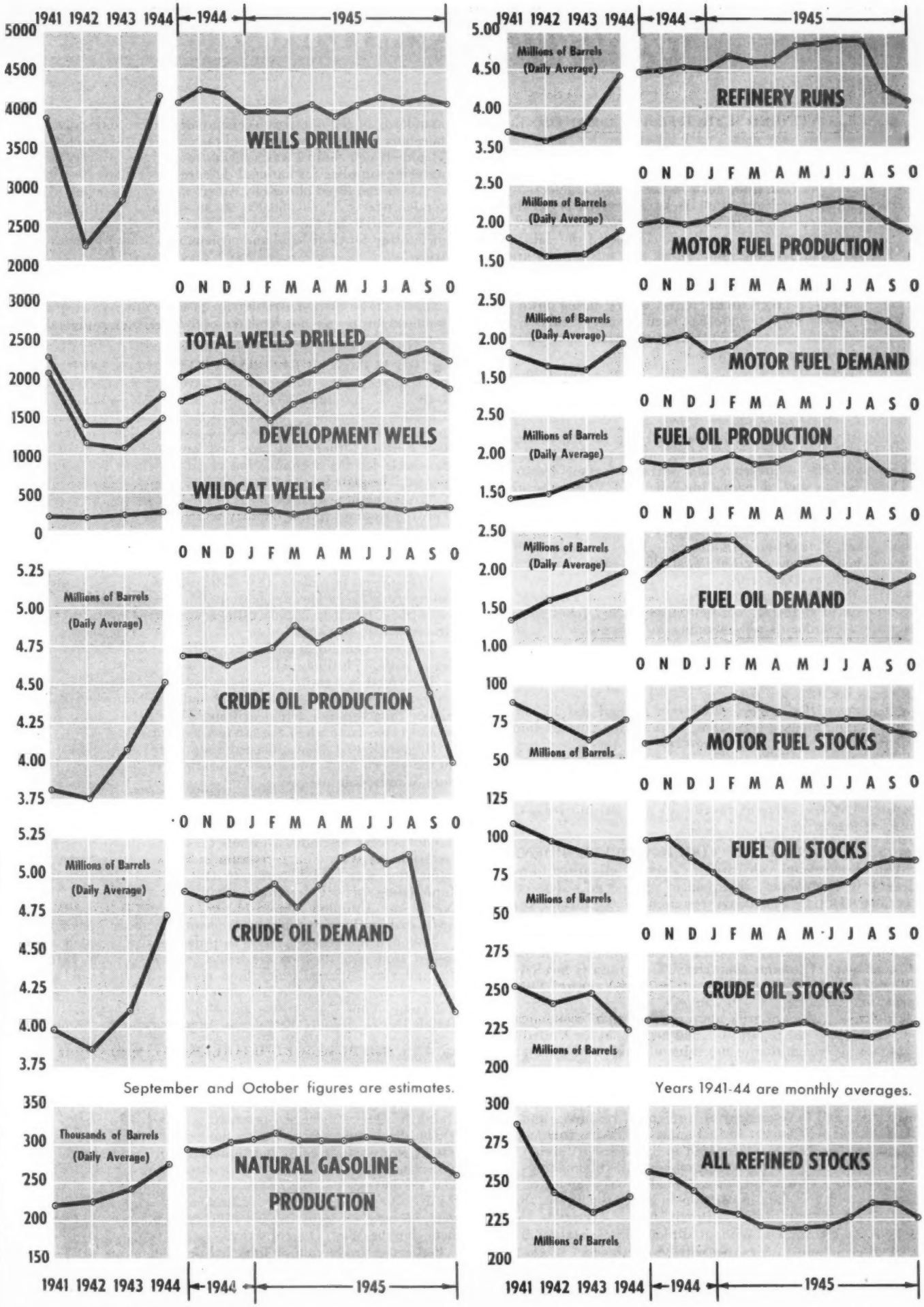
Crude Prices by States for October, 1945§

U. S. average	$1.22	Louisiana	$1.20	**Basic crude prices**	
Texas	1.23	Arkansas	1.25	Oklahoma-Kansas (36 gr.)	$1.17
California	1.07	New Mexico	1.04	Texas Gulf Coast (36 gr.)	1.40
Oklahoma	1.17	Mississippi	1.10	East Texas	1.25
Kansas	1.17	Illinois	1.37	West Texas (36 gr.)	1.04
		Other states	1.89	Calif. Signal Hill (26 gr.)	1.11
				Pennsylvania	3.00

Drilling and Production Statistics by States

	October 1945	Sept. 1945	October 1944	This year to date	Last year to date	Per cent change
Total wells drilled	2,286	2,423	2,102	22,368	18,164	+ 23
Texas	576	599	525	5,889	4,646	+ 27
California	183	152	188	1,902	1,640	+ 16
Oklahoma	155	231	163	1,979	1,414	+ 40
Kansas	157	166	175	1,438	1,522	— 6
Louisiana	93	115	65	930	633	+ 47
Arkansas	18	14	17	143	235	— 39
New Mexico	46	28	47	351	337	+ 4
Mississippi	39	36	9	313	107	+193
Illinois	157	184	194	1,478	1,498	— 1
Other states	862	898	719	7,945	6,132	+ 30
Wildcats drilled	368	366	345	3,444	3,166	+ 9
Texas	120	124	109	1,296	1,129	+ 15
California	30	16	17	208	167	+ 25
Oklahoma	27	42	30	381	304	+ 25
Kansas	33	28	58	314	430	— 27
Louisiana	12	14	13	142	108	+ 31
Arkansas	4	4	5	33	52	— 37
New Mexico	14	10	4	74	54	+ 37
Mississippi	11	9	2	108	66	+ 64
Illinois	35	41	43	304	305	0
Other states	82	78	64	584	551	+ 6
Daily crude production	3,999	4,467	4,740	4,705	4,558	+ 3
Texas	1,506	1,849	2,149	2,072	2,026	+ 2
California	821	869	880	905	846	+ 7
Oklahoma	364	388	352	376	337	+ 12
Kansas	263	262	265	266	270	— 2
Louisiana	353	356	358	356	353	+ 1
Arkansas	74	77	80	79	80	— 1
New Mexico	100	102	104	103	109	— 6
Mississippi	52	54	48	51	44	+ 16
Illinois	188	200	210	205	212	— 3
Other states	278	310	294	292	281	+ 4

§No change since prices frozen. Prices do not include subsidies.
(p) Preliminary. ***Does not include input wells.



September and October figures are estimates.

Years 1941-44 are monthly averages.

Highlights IN OILDOM

● **SEE CONTINUED SEARCH FOR ALASKAN OIL.** Evidence uncovered this year makes navy oil authorities "more confident than ever that there is every justification for continuing the search for oil" in the Barrow Naval Oil Reserve in Alaska.

Capt. B. W. Gillespie, head of the petroleum section of the Navy's Bureau of Yards and Docks, expressed belief the work would be carried on by civilian contractors for the Navy.

All exploratory work has been completed, he said, adding "The Navy has laid the groundwork and full reports are available covering everything we have done and how we did it."

Work at the test well site at Umiat, 331 miles southeast of Point Barrow, on the Colville River, is now closed down for the Winter. Work done to date has been by navy Seabees, but all these are expected to be back home by early next year before the new working season opens.

The Point Barrow deposits were made a naval reserve 20 years ago as a result of surveys made by the geological survey, which, however, hardly touched what ultimately became a reserve of some 35,000 square miles.

Captain Gillespie said the test drill thus far has produced no oil, but every evidence, including oil seepage throughout the area, indicates its presence and warrants further investigation. There is "no way of estimating," he said, "what the ultimate value of the deposit might prove to be."

● **REVISIONS OF LEASING LAW ASKED.** The oil industry has asked Petroleum Administrator Ickes to support its proposed modifications of government policy on the leasing of land for oil and gas exploration.

The Petroleum Industry War Council, an advisory group composed of industry representatives, asked Ickes to endorse certain amendments now pending in congress.

The industry's proposed changes as outlined in a statement, include:

Reduction of royalty on exploratory leases and new discoveries to a flat 12.5 per cent.

Increasing the acreage limitation beyond the 15,360 acres fixed in the proposed legislation, or removing acreage limitation from leases 5 years after discovery.

Permitting two-year options for exploration purposes without acreage limitation.

Eliminating the "asserted authority of the secretary of interior to fix the value of royalty oil and gas in excess of field market prices."

● **SEEK SUPPORT IN FOREIGN DEVELOPMENTS.** A group of petroleum executives, in a report submitted to Senator Joseph C. O'Mahoney, chairman of the special senate committee investigating petroleum resources, has warned that the United States will lose its foreign oil developments and markets unless its companies are "allowed the same freedom of action as foreign competitors to operate in accordance with the laws and customs of foreign countries." The group is headed by B. Brewster Jennings, president of Socony-Vacuum Oil Company, Inc.

"Political risks are even more onerous than economical and physical risks," the report said, and urged that the United States reiterate its recognition of the value of foreign investments and trade in development of American economic life.

"The government of the United States," the report said, "should proclaim to the world its backing of its nationals in their search for and development of foreign oil resources and make clear that it will expect its nationals to receive treatment not less favorable than that accorded to nationals of foreign countries and to competing government-controlled companies."

American interests now are excluded on a minority basis, Jennings' group said, in British India, Baluchistan, Burma, China and the Philippines, Brazil, Chile, Trinidad, Mexico, Bolivia, and Uruguay. Without diplomatic assistance, it said, such discriminatory measures will be continued.

The report said control of an adequate share of foreign oil production and reserves was essential to insure high living standards in the domestic economy of the United States, which accounts for about two-thirds of the entire world's consumption. It added such control was a means toward world peace in guaranteeing supplies for national defense in strategic locations.

Assets employed abroad by American companies and affiliates totaled nearly $2,500,000,000 at the end of 1939, the group reported, and today the companies "find themselves in the position of fighting for their legal and economic existence in many countries.

"It is recognized that nationalization or the threat thereof, the throwing up of trade barriers, government cartels and the like—expected to be carried over into the postwar era in even more pronounced form—do not lend themselves to easy diplomatic solution," the report stated.

● **DESPITE WAR RESERVES HAVE INCREASED.** Proved oil reserves in the United States have increased 56.6 per cent from 1937 through 1944 despite heavy war demand, Frank Phillips, chairman of the board of the Phillips Petroleum Company, said in a recent interview on postwar plans for the industry. Further, "there still are vast areas in the United States favorable for the accumulation of oil that have not been prospected," he stated.

"In the eight years from 1937 to 1944 inclusive," he explained, "proved reserves in this country totaled 18.5 billion bbl.

"Oil production was 11.1 billion bbl. Thus, all needs, including unprecedented military demands, were filled and reserves increased 7.4 billion bbl. or 56.6 per cent.

"This seems to indicate that if the economic forces controlling oil industry operations are permitted to operate freely, sufficient oil will be found to supply all needs, and the upward trend of reserves will continue."

The never-ending hunt for new oil pools will continue "on a large scale," Phillips said.

The trend in hunting new fields he stated, will be toward location of pools through geological and geophysical exploration rather than through actual drilling. The drilling, he indicated, would come later when the oil was needed.

He anticipated a move toward a search for deeper production in the known pools and also exploration "in remote and heretofore inaccessible areas."

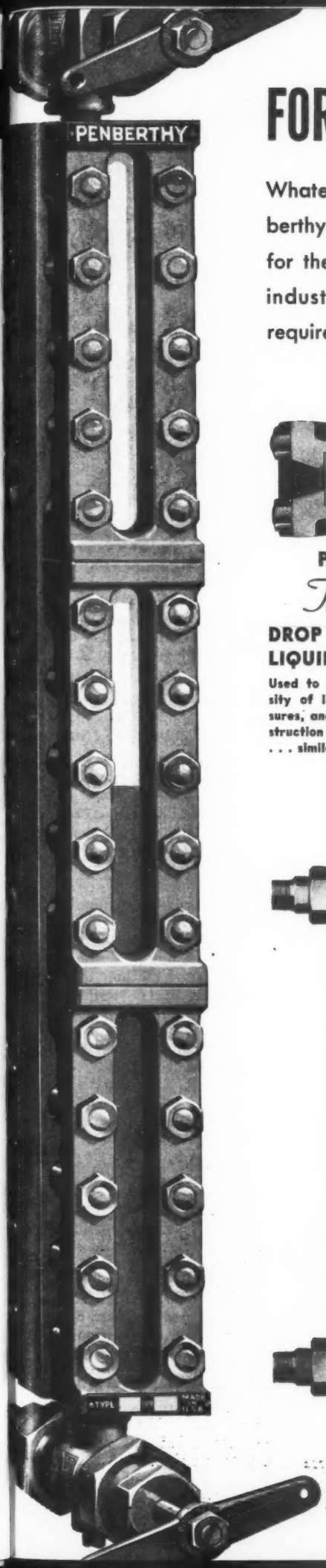
● **OIL TRANSPORTATION CONTROLS RESCINDED.** Controls over supply and transportation of petroleum and petroleum products were rescinded November 1 by the Petroleum Administration for War. The petroleum industry's foreign operating committee was advised prior to that date to discontinue the functioning of subcommittees that, in cooperation with the Navy, war, shipping administration, and the British, have coordinated world-wide tanker movements for the United States.

Although the controls, such as orders and recommendations issued from time to time are being rescinded, PAW Directive 70, under authority of which these controls were issued, will be retained temporarily, but not later than December 31, to permit completion of programs and shipments already instituted, Ralph Davies, Deputy Petroleum Administrator, explained.

● **U. S. OUTPUT LIQUIFIED PETROLEUM GAS TRIPLED.** Production and use of liquefied petroleum gases, including the separate fractions and mixtures of propane and butanes, tripled during the last two years, Deputy Petroleum Administrator Ralph K. Davies disclosed recently.

The disclosure was based on the report of a survey carried out by representatives of the liquefied petroleum gas industry under the direction of the Petroleum Administration for War. The survey covered the entire country, with the exception of PAW'S West Coast District, which comprises California, Arizona, Nevada, Oregon, and Washington. A separate survey was made for the West Coast district.

Estimated production of liquefied petroleum gas—LPG—for 1945 was set at 115,064,829 bbl., an increase of 27 per cent over the 1944 production and more than triple the 1943 production.



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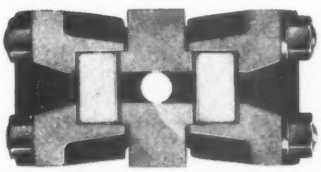

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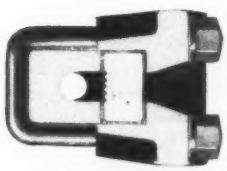

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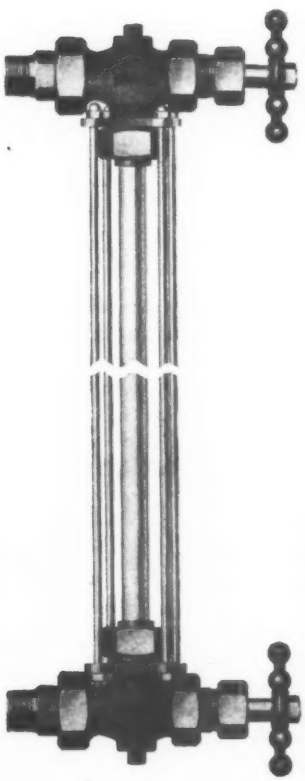

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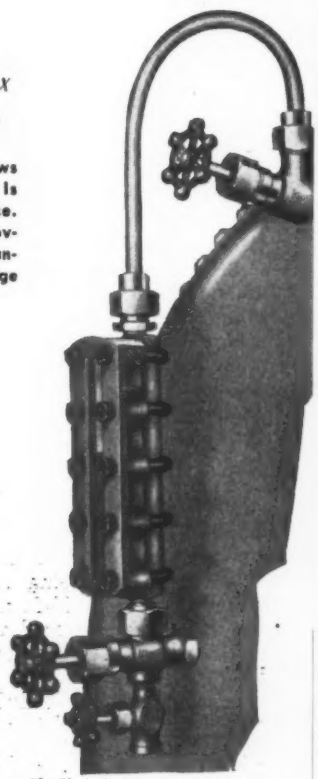

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MAJOR *Oil Field* ACTIVITIES

● **MISSISSIPPI.** A joint operation of Roeser and Pendleton and the Sohio Oil Company gives Jackson County another field. The well is 8 miles southeast of Natchez and about 9 miles from the discovery well of the lush Cranfield field. Operators say they have an excellent oil show.

Clarke County has a new shallow oil pool with the opening of No. 1 Long Bell Petroleum Company. Drilled by L. J. Rousel, the well pumped 85 bbl. of oil in 24 hr. on official potential gage. It is 5 miles south and a mile east of the town of Quitman. It is producing from 3715-17 ft. with total depth at 3800 ft.

● **LOUISIANA.** Lafayette Parish has a new discovery with Shell Oil Company No. 1 F. A. Brossard, a mile east of the North Cankton field. The well flowed an estimated 265 bbl. of 35.5-gravity oil daily from 10,640-655 ft. in the Frio. Tests at 11,025-930 ft. showed gas.

Humble Oil and Refining Company has opened a new deep sand pay in the Avery Island pool of Iberia Parish, coastal Louisiana. The well is No. 1 Hooks, completed through liner in hole from 11,875-85 ft. for 421 bbl. of 47-gravity oil in 24 hr. Total depth was 12,000 ft. in the shale. The regular producing zone in the pool is from the 8700-ft. level.

● **NEW MEXICO. Showing oil in two zones, Levers No. 1-B Levers, northwest Eddy County, opens a new pool 2 miles from the nearest production in the Halfway field and about the same distance south of the High Lonesome producing area. The well showed for production at 2660-65 ft. where it bailed 12 bbl. of oil per day and had an increase in petroleum at 2926-41 ft. Both shows were in lime. Operators are going deeper.**

● **TEXAS.** A gas-condensate pool for central Marion County, East Texas, has been opened by the Stewart Oil Company. The discovery well is the No. Brown Estate, southeast of Lodi. It has been completed for a wet gasser from the Dees zone of the Rodessa at 6198-6210 ft. Total depth is 7200 ft.

Humble No. 1-B Sullivan, Brooks County, opens what will be known as the Pita condensate pool. It made 22.11 bbl. of 48.6-gravity oil daily in sand perforated at 8193-95 ft. with a flow of 67,000,000 cu. ft. of gas.

D. D. Feldman completed No. 1 S. F. Bashara to open deep production on the north flank of the old Saratoga dome, Hardin County. The test was drilled to 6972 ft. and casing set to 6520 ft. The well flowed 395 bbl. of 34-gravity oil through a ¼-in. choke on potential. The Saratoga field was first brought into production in 1901 from the Miocene sand around 500 ft.

New gas-condensate production from the Wilcox sand has been opened 4 miles southeast of the Hope field and southeast of Yoakum in Lavaca County. The well is Sterling Oil and Refining Corporation's No. B-1 Goodrich. Operators are still testing.

Quintana Petroleum Corporation has opened No. 1 Shofner, wildcat in the Port Lavaca area of Calhoun County. The well is being completed in the 5710-20-ft. sand where oil was recovered on a drillstem test. Total depth is 5900 ft.

H. W. Snowden of Dallas has opened a new Frio sand oil pool northwest of the Lane City pool, Wharton County, upper Gulf Coast. The discovery is producing through casing perforations from 5450-54 ft. and will be completed without gage. The discovery is estimated good for several hundred barrels of oil daily. The regular pay in the Lane City pool is from the Marginulina sand, 5335 ft.

Bee County has a new pool opener with Blanco-Buchanan No. 1 C. A. Henderson. The well flowed 480 bbl. of 46-gravity oil from the Pettus sand at 3515-18 ft.

Dual sand completion is slated at Butcher-Arthur, Inc., No. 1 N. R. Dodson, discovery well northwest of the Wilcox sand pool, Coldspring, San Jacinto County. While making a drillstem test at 4490-4500 ft., the well is credited with flowing an estimated 265 bbl. of oil. It showed gas sand at 4375-4400 ft. oil sand at 4490-4503 ft., and wet gas at 5490-5555 ft.

● **INDIANA.** The Magnolia Petroleum Company has set casing and begun further testing of a wildcat well about 6 miles northwest of Owensville, Gibson County. Drilled to a depth of 2360 ft., the well had gas and clean oil from the Aux Vases. It is located about 4 miles from other deep oil wells and opens a considerable new area for development.

● **KANSAS. Sedgwick County has a pool opener with the John Gaty and others No. 1 Stollei. The well is producing 467 bbl. of oil a day from Mississippi chat at 2909 ft.**

The No. 1 Crowther A of Sharon Drilling Company opens a new oil play in McPherson County. The well is the discovery for Battle Hill pool and has been assigned an initial potential of 1724 bbl. of oil daily from the Mississippi chat at 2834 ft.

● **MISSOURI.** A new pool for Missouri is indicated in the Clegg No. 1 Fee, near Grandview, Jackson County. The well had 85,000 cu. ft. of gas from 300-03 ft. Hole was bottomed at 310 ft.

● **OKLAHOMA.** Deep Rock Oil Corporation No. 1 Emma Arrendell, central part of Noble County, has been completed for 20 bbl. of oil an hr. Drilled to a depth of 4600 ft., the well was plugged back for completion in the Wilcox sand, 4594 ft. The wildcat is located near Red Rock.

No. 1 Mottinger, pool opener for McClain County, cored from 10,841-44 ft. and recovered 2½ ft. of tight sand with spotted oil stains. It had previously flowed oil at a rate of 1000 bbl. per hr. on a drillstem test between 10,825-41 ft. Carter Oil Company is the operator.

The Atlantic Refining Company No. 1 Schmidt, wildcat test south of Kremlin, Garfield County, hit a high-pressure gas pocket at 1345 ft. with volume sufficient to blow the hole free of drilling mud. The well later hit in oil sand at 4700 ft. Oil in samples was also reported at 4310 ft. and the Layton was penetrated at 4285 ft.

Wood Oil Company, Sohio Petroleum Company, and Mid-Continent Petroleum Corporation have opened a new well for Cleveland County with No. 1 West-Phal. The discovery well flowed 43 bbl. of oil an hr. for 14 hr. through a 1-in. choke. Production is from the Bartlesville sand through perforations between 7788-7880 ft.

● **ILLINOIS.** C. E. Skiles has completed a well to open a new pool in Gibson County. The discovery is No. 1 Chapman-Courter Community, and the pay in this test, located near Mt. Carmel, is the Cypress sand, 2092-2110 ft. The well made 125 bbl. of oil a day on initial tests.

Good Texas Producers

Two producing zones are found in The Texas Company and Shell Oil Company, Inc., No. 1 Ratliff and Bedford, deep discovery well in southwestern Andrews County. The discovery well made 1214 bbl. of 44.3-gravity oil in 24 hr. from the Ellenburger, lower Ordovician, from a depth of 11,416 ft. The well also flowed 829 bbl. of 42.9-gravity oil in 18 hr. from the Devonian lime from 8850-9150 ft. It will be produced at the same time from both zones. The well also found oil in the lower Permian and the Silurian lime sections both of which were tested and found commercially productive but will not be produced now.

Wichita River Oil Company has opened a 3000-bbl-a-day producer in the central part of Montague County with Kingsbury No. 1. The new well, drilled to 6000 ft., flowed 123 bbl. of oil in the first hour and opened a new area of 600 acres owned jointly by Wichita River Oil, Consolidated Oil Company, and Aro Equipment Company. The well was drilled by the Venmex Oil Company, a wholly-owned subsidiary of Wichita River.

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MAJOR *Pipe Line* ACTIVITIES

● **RIGHT-OF-WAY CLEARED.** Interstate Oil Pipe Line Company is clearing right-of-way for the laying of 34 miles of 10-in line as extensions and 2 miles of 6-in. lines to Gwinville, Mississippi. O. E. Dempsey Construction Company has been moving in equipment from Louisiana for the work.

● **TANKERS RELEASED.** The war shipping administration has issued an order for the return to their American owners of all tankers of more than 3000 gross tons in accordance with a decision reached at a recent meeting of the united maritime executive board which met in Washington. The order took effect at midnight October 31 and affected about 300 tankers owned by American citizens under American or foreign registry or owned by any wholly-owned foreign subsidiary of American citizens now under time charter requisition or bareboat charter to the W.S.A. and which are declared surplus to the operating needs of the government.

● **PLANS PROGRESS. Negotiations have been reported as proceeding satisfactorily for the laying of a 1200-mile pipe line between Dhara, Saudi-Arabia, and the coast of Palestine by American Trans-Arabian Pipe Line Company. Lord Gort, British high commissioner in Palestine, is expected to sign an agreement in Jerusalem shortly giving the company a right-of-way for the $160,000,000-line across Palestine.**

● **POOL GETS OUTLET.** A pipe-line outlet for the New Dollar Hide Ranch oil pool is being provided by The Texas-New Mexico Pipe Line Company. The pool, recently opened by Humble Oil and Refining Company and The Magnolia Petroleum Company, is near Fort Worth, Texas.

● **SEEK GAS LINE PERMISSION.** The Southern California Gas Company and the Southern Counties Gas Company have filed application for permission to build and operate 214 miles of natural gas lines from Blythe to Santa Fe Springs, California. With an initial daily capacity of 175,000,000 cu. ft. and an ultimate capacity of 305,000,000 cu. ft., the artery will cost $15,000,000. It will connect with existing pipe lines at Santa Fe Springs for distribution throughout southern California. Gas for the line will be purchased from the El Paso Natural Gas Company in Texas, according to F. S. Wade, president.

● **ADDITIONAL LINES.** Southern Natural Gas Company, Birmingham, Alabama, has initiated work on approximately 50 miles of 22-in., 17 miles of 20-in., 14 miles of 12-in., and 10 miles of 6-in. pipe-line loops in the states of Mississippi, Alabama, and Georgia. The 22- and 20-in. loop lines are to be composite construction, using couplings and welds alternately, whereas the 12- and 6-in. loop lines will be solid welded. Three multiple river crossings are to be installed across the Tombigbee River in Mississippi and the North and Warrior rivers in Alabama. Construction work is being done by H. C. Price Company, Bartlesville, Oklahoma. Ford Bacon and Davis Construction Corporation, New York City, are the engineers on the project.

● **HALF FINISHED.** Oklahoma Natural Gas Company has completed about 50 per cent of the work in replacing 30 miles of its 96-mile high-pressure line from Chickasha, Oklahoma, to Stroud, Oklahoma. The line is covered with asphalt-mastic coating.

● **HEARING SET.** January 8 has been set by FPC as the date for hearing on an application for construction of a natural gas pipe line from Texas to Michigan. The $70,000,000 project is planned by the Michigan-Wisconsin Pipe Line Company, subsidiary of the American Light and Traction Company. Terminus of the line would be in Detroit, where the Michigan Consolidated Gas Company supplies gas largely from the Panhandle Eastern Pipe Line Company. The city of Detroit recently told the commission that it opposed an application of Panhandle Eastern to export gas to Canada if it meant that Detroit's needs could not be filled.

● **RELAY LINES. Empire Southern Gas Company, Ft. Worth, Texas, has completed relaying lines in the Shaeffer Lake field at an estimated cost of $260,000. Nineteen miles of 2-in. high-pressure line was relaid from each of the company's wells to a centralized control station. Forty-one miles of 8-in. seamless pipe connected the control station in Ector County with the Big Spring, Texas, line at the junction in Martin County.**

● **CONSTRUCTS OUTLET.** The Texas-New Mexico Pipe Line Company is building a 4-in. line to its Wink-Crane trunkline system from Atlantic Refining Company's recent discovery in Crane County, Texas. The carrier will be 1⅞ miles long. Allowable for the new dual-pay well has been set at 180 bbl. per day from the Devonian and 220 bbl. per day from the Ellenburger.

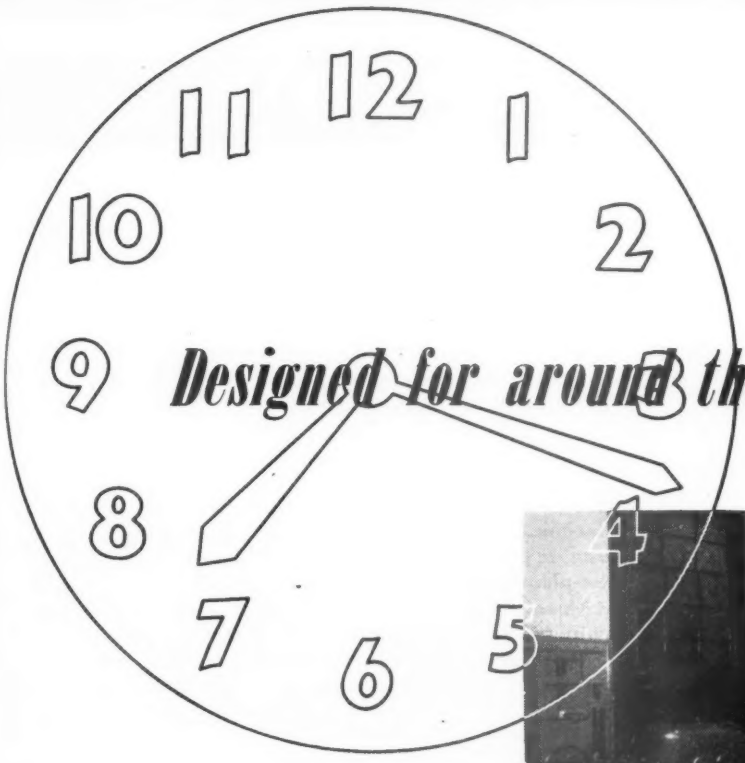
● **REDUCE GAS RATES.** About $24,000,000 will be refunded to customers of the Panhandle Eastern Pipe Line Company following the acceptance by FPC of revised rate schedules by the company. The rates are 32 per cent below 1944 billings. Acceptance of the new schedule is a result of a Supreme Court Decision of April 2 upholding a commission order directing Panhandle to reduce its rates by "not less than $5,094,384" under 1941 rates. It has not been determined whether the reduction will be passed on to retail customers. The Panhandle system supplies the natural gas used in more than 200 cities, towns, and communities with more than 700,000 retail customers in Texas, Kansas, Missouri, Illinois, Indiana, Michigan, and Ohio.

● **OPPOSE USE OF LINES.** The United Mine Workers of America and the citizens and communities of mine region towns have expressed to Congress concern over the possible disposition of the Big Inch and Little Big Inch pipe lines. Representative Flood told house members "governmental operation of, or subsidy to, the marketing of competing fuels would effect the lives of approximately 700,000 coal miners and their families." He said that the coal interests felt the pipe lines were wartime projects and are, therefore, expendable just as any other temporary investment and should not be leased or sold to private industry or be government-operated or subsidized. They should, according to Flood's statement, be held intact in reserve for any future emergency.

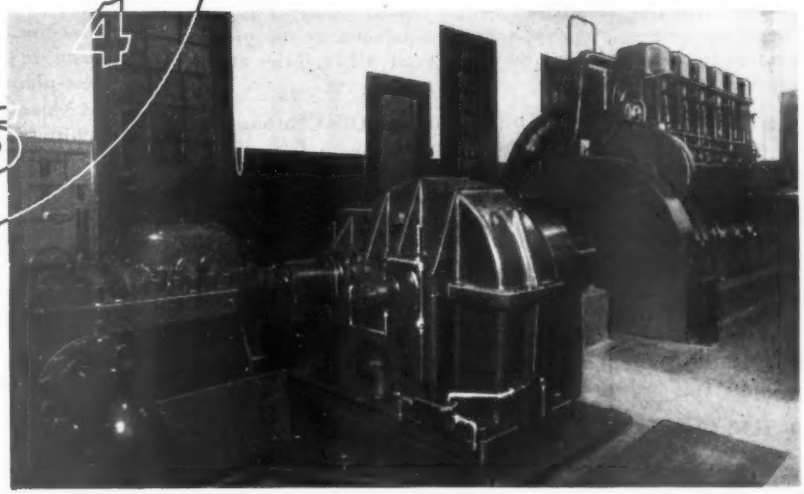
"To allow oil or natural gas to be unfairly delivered through this medium into the coal markets of this country, and thus improperly compete with the abundant coals now being produced by private industry, would certainly tend to interrupt and impede seriously postwar reconversion and recovery," Flood said.

Standard of California builds line

A new 175-mile pipe line costing more than $3,000,000 to link the San Joaquin Valley oil fields with San Francisco Bay, will be built by Standard of California within the next few months. With pumping capacity of more than 90,000 bbl. daily, the 18-in. line will run from Kettleman Hills, Kings County, to Los Medanos, the oil company's big tank farm near Pittsburg, on the upper bay. Construction is expected to begin in December, with completion scheduled for April. This line will permit the Stanpac line to be reconverted to transportation of natural gas. Stanpac was changed over from natural gas to crude petroleum early in 1942 to meet the tanker shortage and is credited with having made possible the production records set by the Richmond refinery. Bechtel Brothers-McCone Company was awarded the construction contract. Additional items included in the total cost are rights-of-way and 21,000 tons of pipe, to be supplied by A. O. Smith Corp. of Milwaukee, Wisconsin.



Designed for around the clock operation

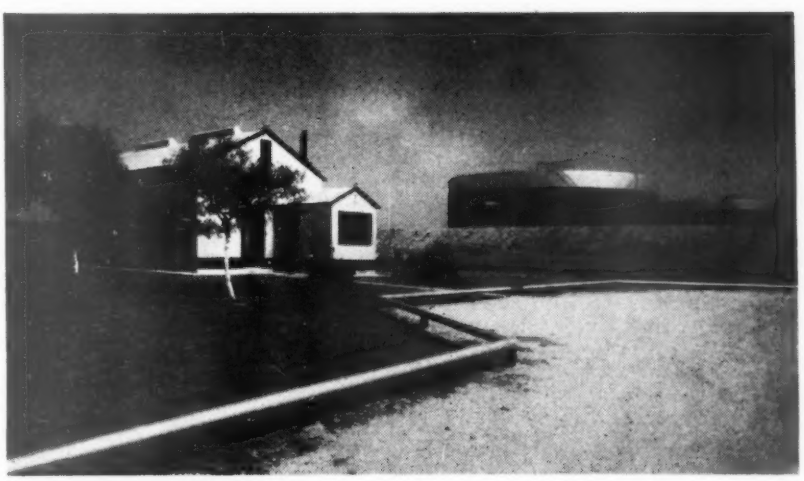


The centrifugal pump is driven by a Westinghouse gear speed increaser. Both are mounted on a common bed plate to preserve alignment.

THE *extra* precision in Baldwin Diesel Engines pays especially big dividends in the isolated pumping stations where the "tricks" are 24 hours long, and there's no stand-by equipment.

The pioneer diesel-powered pipe line in this country was equipped with Baldwin Diesels, and today hundreds of installations all over the nation depend on the same reliable equipment. The illustrations show a typical application . . . a 6-cylinder Baldwin driving a centrifugal pump through step-up gears.

Baldwin Diesels for pipe line service are available from 465 to 760 b.hp., over a speed range from 300 to 450 r.p.m., in stationary, portable, and semi-portable types. Ask for detailed information. The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.



A typical modern pumping station.

BALDWIN

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DIESEL ENGINES

4903

MAJOR *Refining* ACTIVITIES

● **BUTADIENE PLANT TO CLOSE.** Humble Oil and Refining Company officials have confirmed rumors regarding the closing down of the government-owned Humble-operated butadiene plant at Ingleside, Texas. The rubber reserve division of RFC has given notice of cancellation of the contract for the manufacture of butadiene. The cancellation will become effective not later than 90 days from the date on which the notice of cancellation was received. The Government has requested that the closing down be expedited and concluded as early as practicable. During the war years the refinery's principal output was butadiene and other war products. The refinery, excluding war products, is now merely a topping plant. It is not practicable to operate with the butadiene section closed down, it is stated. Therefore, company officials say that as soon as the problems incident to the closing can be worked out, all facilities at Ingleside will be shut down.

● **TO OPERATE PLANT. Standard Oil Company of California has entered into a contract with RFC under which the company will operate the major part of the government-owned 100-octane plant at Richmond, California. One of the nation's largest wartime producers of military aircraft fuel, the plant will now be reconverted to manufacture premium quality motor gasoline for automobiles. Standard's decision to lease the plant is in keeping with its policy to improve peacetime products and to provide employment for skilled workers in the west. Operation and maintenance of the plant will require about 150 technical and skilled personnel.**

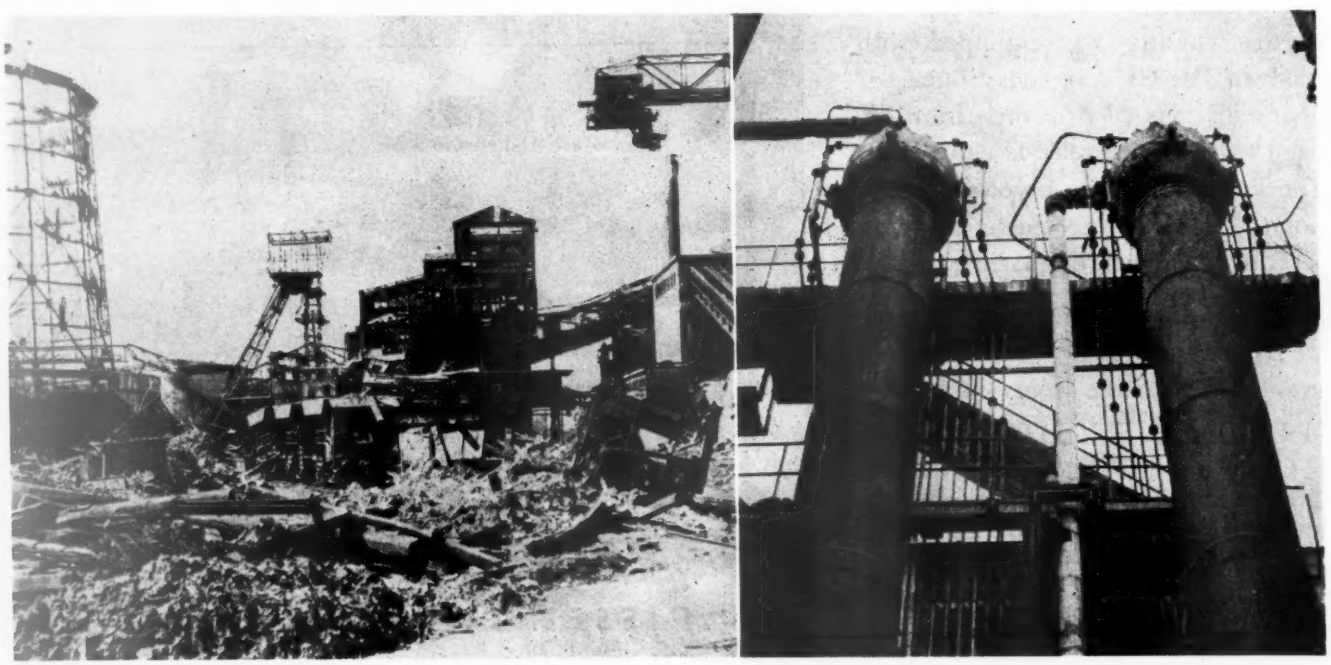
● **GAS COMPANY SOLD.** The Western Kentucky Gas Company, Owensboro, Kentucky, has been sold to W. T. Stevenson, owner of Owensboro Gas Company, according to L. E. Ingham, vice president of the Kentucky Natural Gas Corporation. The gas company was a wholly-owned subsidiary of the Kentucky Natural Gas Corporation. Simultaneous with the announcement, Stevenson revealed the merger of the Owensboro Gas Company and the Western Kentucky Gas Company. The merger, which took place November 1, serves 38 communities and 16,358 customers in western Kentucky. All present employes of both companies will be retained, Stevenson said.

● **INDIANA STANDARD LETS CONTRACT.** Standard Oil Company of Indiana has let a contract to Stone and Webster Engineering Corporation for the design and manufacture of a steam and electric generating station at the company's refinery at Whiting, Indiana. Designed for future expansion, the station will include in the initial installation a 10,000-kw. high pressure topping turbine generator unit and 2 steam boilers each of which will have a continuous steaming capacity of 300,000 lb. per hr. at 1350 lb. per sq. in. gage. The new facilities will be ready for operation by spring, officials say.

● **NATURAL GAS PLANT. The Saska Corporation, Houston, Texas, has begun construction of a natural gasoline plant in the Quitman pool, Wood County, Texas. The plant is the first for the field. It is 3 miles north of Quitman. Charles A. Schwartz, consulting construction engineer and president of the firm, said plans are to put the refinery in operation by January 1. The plant will make 26-70 natural gasoline, a product used by refineries as a blend for lower grade stock, according to Schwartz.**

● **RECONSTRUCTION PROGRAM.** It will require 3 years to rebuild the plants of Standard Oil Company of New Jersey in Europe, damaged by war, according to a Jersey official. It may take equally as long to estimate fully accurate figures of war losses. Robert T. Haslam, vice president and director of the company, after a 2-month survey revealed the conditions of the plants as "quite spotty—some installations were scarcely touched, others damaged badly." Haslam said that by makeshift methods most of the company's plants will be in running condition without delay.

● **DIVISION EXPANDED.** Thhe engineering division of the Sugar Creek, Missouri, refinery of Standard Oil Company of Indiana is being expanded according to Dr. M. G. Paulus, vice president in charge of manufacturing. G. W. Larson, chief engineer, will continue to supervise the division, now including the design and plant engineering departments.



Left, only the framework of building and equipment of this Fischer-Tropsch gas synthesis plant between Kamen and Dortmund in the Ruhr, Germany, was left after Allied bombers raided the area. Right, these converters in the Gelsenberg plant changed coal paste into oil. Principles of production in both plants are now being studied by American industry.

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AVERAGE GAS-OIL RATIO OF NATION'S OIL FIELDS

By **K. MARSHALL FAGIN,** *Field Editor*

THE petroleum industry's attention is being focused more and more on the perennial problem of reducing the amount of gas produced with oil from wells of the United States, especially in fields where operators of high gas-oil ratio wells are penalized by a reduction in daily oil allowable.

EXCLUSIVE

Those who are familiar with the operation of oil wells realize the serious economic plight of hundreds of wells that are almost penalized out of existence as oil wells by (1) an expanding gas cap, (2) a rapid release of gas from solution in the crude oil as declining reservoir pressure reaches the "bubble point," (3) a downward channeling of gas from a gas cap due to an excessively high production rate, or (4) by the inability of operators to workover wells in a way that will provide an enduring seal between oil and gas producing zones.

Most of the severely penalized wells have gas-oil ratios ranging from 50,000 to 100,000 cu. ft. of gas per bbl. of oil. This ratio range may be considered as the twilight zone between oil wells and gas wells, and unless an operator can effectively workover his well greatly to reduce such a high ratio, the chances are good that he will have to be content with a daily allowable of 1 to 5 bbl. of oil in states with strict conservation rules.

● **Gas conserved increases oil recovery.** Regardless of the economic consequences so far as these excessively high gas-oil ratio wells are concerned, the people of the nation as a whole, including the oil well operators, are benefited by the conservation of much gas that might otherwise be produced and wasted, and by a greater ultimate recovery of crude oil from the oil-producing reservoirs of the nation. Expanding gas supplies the bulk of the energy needed to produce the oil from the formation into the well. The gas-oil ratio is a measure of the efficiency of the oil producing process.

Low ratio means high efficiency and high ratio, low efficiency in crude oil recovery.

Those who have witnessed the orange-colored glow in the night skies over some of the large oil fields have probably wondered how much gas was being burned in the flares to create such huge, bright spectacles. They may also have wondered how so much gas could be wasted in conformance with our various "conservation" laws, but that is only the visible waste, and is, unfortunately, regarded as necessary in the production of crude oil in areas where there is no demand for the gas, or where the gas is not returned to the reservoir by the operators through a pressure maintenance agreement.

The invisible waste, or underground waste, is the loss of gas energy that spells a reduction in ultimate oil recovery from the reservoirs. The loss of gas energy is reflected early in the life of a field by the declining bottom hole pressure, except in fields where the pressure is supplied by encroaching water. Even in these water-drive fields, the loss of gas energy may be much faster than replacement of the energy by encroaching water, and the initial bottom hole pressure may show a rapid decline.

● **Gas-oil ratios usually increase.** Working over oil wells to reduce the gas-oil ratio is a perennial problem, inasmuch as most of the nation's oil wells are situated in solution gas-drive type of reservoirs. The initial ratios of wells completed in these reservoirs are usually low, ranging from 300 to 700 cu. ft. per bbl., but the bottom hole pressure declines and the gas-oil ratios increase as oil and gas are produced.

Although much time and money is often spent in attempts to reduce the gas-oil ratios of the individual wells, the beneficial results in solution gas-drive fields seldom last more than 2 to 20 months. By that time the gas liberated from solution has usually found its way into the well bore, and the ratio is as high as when the workover began. Some wells, however, may be profitably worked over several times in the same producing

formation. The profitableness of the work to the individual operator depends largely on the amount of additional allowable oil production that is granted as a result of obtaining a temporarily lower gas-oil ratio.

● **Gas returned to reservoir increases yield.** Pressure maintenance probably offers the best known solution to this problem of retaining the gas energy in a reservoir. It is simply the returning into the oil-bearing formation of all gas not used in lease operations. This procedure requires considerable preliminary study of well and producing formation conditions plus detailed planning of the gas collection, compressing, and injection system. Such planning is often complicated by divided ownership of the operating leases and royalties, but it will save most of the gas and increase the ultimate recovery of oil as much as 40 per cent when applied in the early life of a field and properly engineered.

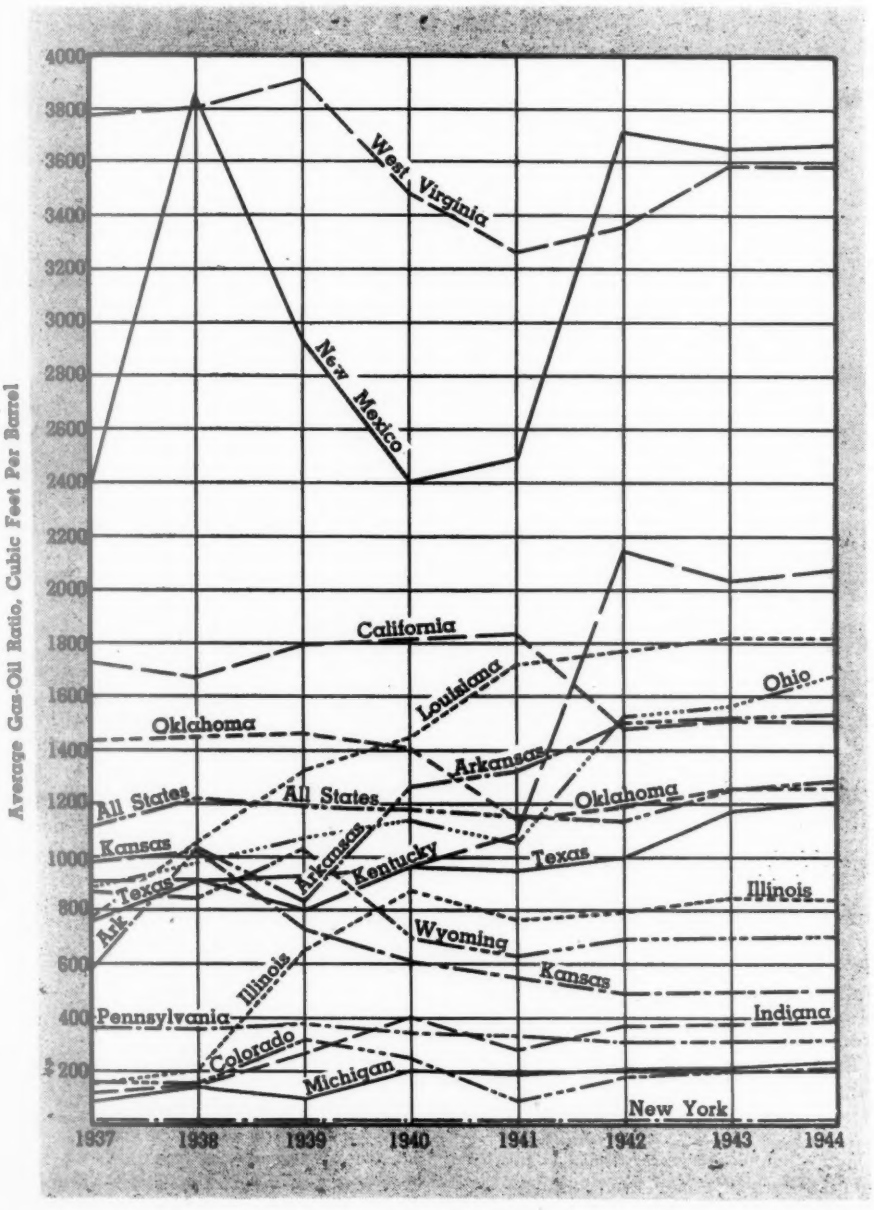
Conservation of gas in the State of Texas is exemplified by the statewide gas-oil ratio limit of 2000 cu. ft. per bbl. Those wells that produce more than that much gas per barrel of oil are called high gas-oil ratio wells. The daily oil allowables are reduced in proportion to the ratios in excess of that amount as determined by periodic gas-oil ratio tests of the individual wells. A well that has a regular allowable of 20 bbl. a day, for example, could produce that much oil and 40,000 cu. ft. of gas without penalty, but, if a periodic gas-oil ratio revealed the gas-oil ratio was 4000 cu. ft. per bbl., the well would be allowed to produce only 40,000 divided by 4000, or 10 bbl. of oil.

Thus, operators of oil wells in Texas are benefited materially by keeping the gas oil ratios of their oil wells below the statewide limit. This limit, of course, is much higher than the average well needs to utilize properly the energy of the expanding solution gas to produce the oil, but, despite this fact, thousands of wells are troubled with high gas-oil ratios, and remedial work is constantly in progress in many fields.

Similar gas-oil ratio limits are a part of the conservation rules of the states Arkansas, Louisiana, Oklahoma, Kansas, and Mississippi for all or a part of the oil wells within their borders, but some of the states make little or no effort to conserve gas produced by oil wells. Much of the gas from oil wells in some of these states, however, is used to supply local demands for fuel, and is not wasted except as the ultimate recovery of oil may be reduced materially by withdrawal of the gas from the oil producing formations.

● **Most oil well gas is not metered.** Although only a small part of the total gas produced from oil wells is metered and recorded, estimates of the total gas produced from oil wells have been made by the U. S. Bureau of Mines for a number of years in the Mineral Yearbooks. These estimates, by states, and the records of crude oil production, together with the average gas-oil ratios as computed by the writer from these data, are shown in Table 1. Estimates of gas produced from oil wells prior to the year 1937 were made by the Bureau, but are not included in this article. The gas-oil ratios obtained from the production figures in Table 1 are shown graphically in Fig. 1.

FIG. 1.



The last footnote on Table 2 should be carefully noted, in order to prevent any misunderstanding about the completeness or incompleteness of the figures assembled and estimates made by the Bureau. Apparently, not all the data on "direct waste of gas on producing properties" were available to the authors of the statistics. The estimates of gas production from gas wells (Table 2) is likely to be more complete than the estimates of gas production from oil wells, thus, the average gas-oil ratios based on the Bureau's estimates are likely to be low in cases where the data on direct waste were not available.

● **Classification of fields is difficult.** One of the principal sources of difficulty in compiling the estimates of gas produced from oil wells is the question of knowing whether an oil field actually produces crude oil or condensate. Many fields produce both types of liquid hydrocarbons, and a few condensate fields are incorrectly carried on some reports as oil fields. This difficulty of correct classification has increased since 1937 due to the comparatively rapid development of many new gas-condensate fields.

Condensation of the heavier hydrocarbons from the "wet" gas produced from these gas-condensate type of reservoirs is a phenomenon known as retrograde condensation, and the liquid is often referred to as retrograde condensate. Normally, condensation of the hydrocarbons, such as propane, butane, pentane and heavier, takes place as the gas pressure is increased, and not as it decreases. Compression type gasoline plants make use of the normal condensation process, but most cycling plants and scrubber plants utilize the retrograde type of condensation in processing "wet" gas from gas-condensate reservoirs.

The difficulty of classification is complicated further by the fact that the gas

from oil wells in a given field is often inseparable from gas produced from gas-condensate wells in the same field. This is generally true in fields with multiple reservoirs, and sometimes in fields that produce condensate from a few wells completed in a gas cap in the upper portion of an oil-bearing formation.

For the above reasons it is almost impossible to obtain uniformly segregated statistics for a compilation of natural gas production by source, but the estimates obtained from the U. S. Bureau of Mines' Mineral Yearbooks and presented in this article are probably more carefully segregated and complete than any other published data on the subject for the Nation as a whole.

● **U. S. Average ratio is 1278 cu. ft. per bbl.** The estimated average gas-oil ratio of all the oil wells in the United States was 1278 cu. ft. per bbl. during 1944 compared with 1109 cu. ft. per bbl. during 1937. Although this is a ratio increase of only 169 cu. ft. per bbl. during the 8-year period, the total gas produced from oil wells increased from 1,419,830 million cu. ft. to 2,144,720 million cu. ft.. representing a total gain of 724,890 million cu. ft. The large gain in the total volume, therefore, is largely due to increased oil production rather than to increased gas-oil ratio. This may be interpreted by some as indicating an improvement in the conservation of gas, inasmuch as many of the newer, deeper oil fields have higher gas-oil ratios than the older, shallower oil fields, but the ratios of the oil wells in some of the individual states increase from year to year. The ratios in other states decrease, and most state ratio curves fluctuate considerably. The reasons for these variations may be many. Some of the reductions in the gas-oil ratios of some of the states are probably due to actual reductions resulting from a reduction in the gas-oil ratio limits, or the introduction of more pressure maintenance, or better compliance with the rules, but a large part of the apparent reduction in the gas-oil ratio in some of the states is probably due a reclassification of oil wells to gas wells or gas-condensate wells, or more oil production from low ratio water-drive fields.

● **New Mexico and West Virginia.** Fig. 1 reveals large variations in the gas-oil ratio of the oil wells in the states of New Mexico and West Virginia, and yet none of the other states is credited with such high ratios as these two states during the 8-year period from 1937 to 1944. New Mexico's ratio increased sharply from 2367 cu. ft. per bbl. in 1937 to 3859 cu. ft. per bbl. in 1938. By 1940, it was down to about 2400 cu. ft. per bbl. but by 1942, it was up again to 3705 cu. ft. per bbl. It is now estimated to be 3665 cu. ft. per bbl.

West Virginia, surprisingly enough to many of us, has consistently produced more gas with its oil than any other state in the nation, except New Mexico. The gas-oil ratio of West Virginia has ranged from 3910 cu. ft. per bbl. in 1939 to 3262 cu. ft. per bbl. in 1941. It is now estimated to be about 3600 cu. ft. per bbl. The high gas-oil ratio in this state may be partly due to the demand for natural gas in that area, and partly to the inclusion of some gas well production in the "gas from oil wells" column.

On the other hand, the average gas-oil ratio of many of the old casinghead oil wells may be very high. Those who have measured the gas-oil ratios of some

TABLE 1. Estimated average gas-oil ratio of oil wells in the United States—by states.

State	1937			1938			1939			1940		
	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.
	Gas, million cu. ft.	Oil, thousand bbl.		Gas, million cu. ft.	Oil, thousand bbl.		Gas, million cu. ft.	Oil, thousand bbl.		Gas, million cu. ft.	Oil, thousand bbl.	
Arkansas	6,800	11,764	578	18,900	18,180	1039	17,800	21,238	838	32,500	25,775	1261
California	413,000	238,521	1731	419,000	249,749	1677	403,000	224,354	1796	404,800	223,881	1808
Colorado	250	1,605	155	225	1,412	159	450	1,404	320	400	1,626	246
Illinois	1,170	7,499	156	4,850	24,075	201	61,800	94,912	651	129,900	147,647	879
Indiana	100	844	118	150	995	150	450	1,711	263	2,000	4,978	401
Kansas	69,700	70,761	985	62,000	60,064	1032	44,000	60,703	725	40,000	66,139	604
Kentucky	5,000	5,484	911	5,300	5,821	910	4,500	5,621	800	5,000	5,188	963
Louisiana	70,000	90,924	769	100,800	95,208	1059	125,000	93,646	1334	150,000	103,584	1448
Michigan	1,500	16,628	90	2,700	18,745	144	2,250	23,462	95	4,000	19,753	202
Mississippi	....	....	....	....	....	....	10	107	93	300	4,400	68
Montana	900	5,805	155	800	4,946	162	1,200	5,960	201	1,300	6,728	193
New Mexico	92,000	38,854	2367	138,000	35,759	3859	110,000	37,637	2922	94,000	39,129	2402
New York	100	5,478	18	90	5,045	18	100	5,098	20	100	4,999	20
Ohio	3,200	3,559	899	3,200	3,298	970	3,400	3,156	1077	3,600	3,159	1139
Oklahoma	328,000	228,839	1433	254,000	174,994	1451	234,000	159,913	1463	220,000	156,164	1408
Pennsylvania	7,000	19,189	364	6,200	17,426	356	6,500	17,382	373	6,000	17,353	345
Texas	390,000	510,318	764	435,000	475,850	914	450,000	483,528	930	475,000	493,209	963
West Virginia	14,500	3,845	3771	14,000	3,684	3800	14,000	3,580	3910	12,000	3,444	3484
Wyoming	16,600	19,166	866	16,000	19,022	841	22,200	21,454	1035	18,000	25,711	700
Other states*	10	77	129	10	82	121	20	96	208	20	347	58
Total U. S.	1,419,830	1,279,160	1109	1,481,225	1,214,355	1220	1,500,680	1,264,962	1186	1,598,920	1,353,214	1182

State	1941			1942			1943			1944		
	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.	Production from oil wells†		Average GOR, cu. ft. per bbl.
	Gas, million cu. ft.	Oil, thousand bbl.		Gas, million cu. ft.	Oil, thousand bbl.		Gas,‡ million cu. ft.	Oil, thousand bbl.		Gas,‡ million cu. ft.	Oil, thousand bbl.	
Arkansas	34,800	26,327	1321	40,000	26,628	1502	42,000	27,600	1522	45,000	29,435	1529
California	423,500	230,263	1839	367,700	248,326	1480	430,000	284,235	1513	470,000	311,770	1508
Colorado	200	2,150	93	400	2,199	182	450	2,320	194	600	2,990	201
Illinois	101,500	132,393	767	85,000	106,391	799	70,000	82,260	851	65,000	77,050	844
Indiana	2,100	7,411	283	2,490	6,743	369	2,000	5,283	379	2,000	5,050	396
Kansas	46,000	83,242	552	48,000	97,636	492	53,000	106,178	499	50,000	99,000	505
Kentucky	5,200	4,762	1088	9,700	4,534	2139	16,000	7,883	2030	20,000	9,620	2079
Louisiana	199,700	115,908	1722	205,400	115,785	1773	225,000	123,592	1820	235,000	129,400	1816
Michigan	3,200	16,359	196	4,500	21,754	207	4,400	20,768	212	4,200	18,510	227
Mississippi	590	15,327	38	2,300	28,833	80	2,500	18,807	133	2,600	16,400	159
Montana	1,500	7,526	199	1,600	8,074	198	1,600	7,916	202	1,700	8,530	199
New Mexico	98,600	39,569	2492	116,900	31,544	3705	140,000	38,411	3645	145,000	39,560	3665
New York	100	5,185	19	100	5,421	18	100	5,059	20	100	4,700	21
Ohio	3,700	3,510	1054	5,400	3,543	1524	5,200	3,322	1565	5,000	2,970	1684
Oklahoma	176,300	154,702	1140	167,000	140,690	1187	155,000	123,152	1259	157,000	124,650	1260
Pennsylvania	5,700	16,750	340	5,500	17,779	309	5,000	15,757	317	4,500	14,140	318
Texas	480,000	505,572	949	482,100	483,097	998	700,000	593,520	1179	903,000	748,250	1207
West Virginia	11,200	3,433	3262	12,000	3,574	3357	12,000	3,349	3583	11,000	3,070	3583
Wyoming	19,000	29,878	635	22,700	32,812	692	23,000	33,077	695	23,000	32,710	703
Other states*	20	1,961	10	20	1,282	16	20	687	29	20	514	39
Total U. S.	1,612,910	1,402,228	1150	1,578,810	1,386,645	1138	1,887,270	1,503,176	1256	2,144,720	1,678,319	1278

Notes: *Other states include Alabama, Florida, Missouri, Nebraska, Tennessee and Utah.
†Estimates of gas and oil produced from oil wells taken from "Minerals Yearbooks" of the U. S. Bureau of Mines
‡Estimates made by the author or obtained from various sources.

TABLE 2. Estimated gross production of natural gas in the United States—by states.

(All figures are in millions of cu. ft.)

State	1937		1938		1939		1940		1941		1942	
	From gas wells	Total from all wells	From gas wells	Total from all wells	From gas wells	Total from all wells	From gas wells	Total from all wells	From gas wells	Total from all wells	From gas wells	Total from all wells
Arkansas	5,700	12,500	5,300	24,200	6,200	24,000	8,500	41,000	10,200	45,000	9,000	49,000
California	10,000	423,000	13,000	432,000	27,000	430,000	25,200	430,000	36,500	460,000	104,900	472,600
Colorado	3,050	3,300	1,775	2,000	1,850	2,300	2,500	2,900	3,100	3,300	4,700	5,100
Illinois	30	1,200	150	5,000	1,200	63,000	1,100	131,000	900	102,400	1,500	86,500
Indiana	1,700	1,800	1,350	1,500	950	1,400	1,200	3,200	1,400	3,500	1,200	3,690
Kansas	57,000	126,700	54,000	116,000	66,000	110,000	75,000	115,000	77,000	123,000	77,000	125,000
Kentucky	55,500	60,500	46,000	51,300	48,500	53,000	54,000	59,000	71,000	76,200	78,000	87,700
Louisiana	290,000	360,000	260,000	360,800	288,000	413,000	285,000	435,000	375,100	574,800	463,700	669,100
Michigan	7,900	9,400	7,900	10,600	9,150	11,400	10,000	14,000	11,900	15,100	13,400	17,900
Mississippi	14,300	14,300	14,300	14,300	15,290	15,300	6,500	6,800	4,450	5,040	1,500	3,800
Missouri	460	470	1,490	1,500	640	650	390	400	200	210	100	110
Montana	24,600	25,500	20,900	21,700	22,800	24,000	25,900	27,200	27,000	28,500	29,900	31,500
New Mexico	20,000	112,000	30,000	168,000	35,000	145,000	32,000	126,000	34,100	132,700	37,900	154,800
New York	21,900	22,000	40,910	41,000	30,900	31,000	15,100	15,200	12,400	12,500	10,700	10,800
Ohio	42,300	45,500	35,800	39,000	40,600	44,000	46,400	50,000	47,500	51,200	49,100	54,500
Oklahoma	112,000	440,000	76,000	330,000	76,000	310,000	90,000	310,000	99,100	275,400	135,600	302,600
Pennsylvania	118,000	125,000	80,000	86,200	97,000	103,500	96,000	102,000	99,300	105,000	99,400	104,900
Texas	650,000	1,040,000	715,000	1,150,000	880,000	1,330,000	1,100,000	1,575,000	1,337,000	1,817,000	1,508,800	1,990,900
West Virginia	152,500	167,000	136,000	150,000	158,000	172,000	193,000	205,000	212,100	223,300	219,500	231,500
Wyoming	23,000	39,600	22,400	38,400	22,500	44,700	22,000	40,000	24,600	43,600	23,800	46,500
Other states*	2,640	2,640	4,700	4,700	5,240	5,250	5,390	5,400	5,740	5,750	5,390	5,400
Total U. S. production	1,612,580	3,032,410	1,566,975	3,048,200	1,832,820	3,333,500	2,095,180	3,694,100	2,490,590	4,103,500	2,875,090	4,453,900
Estimated disposition:												
Total marketed production		2,407,620		2,295,562		2,476,756		2,660,222		2,812,658		3,053,475
Total repressuring and cycling		84,925		101,551		171,401		362,916		644,379		755,971
Total stored in ground		13,706		14,981		8,032		14,995		16,251		17,672
Total lost and wasted†		526,159		636,106		677,311		665,967		630,212		626,782

Notes: *Other states include Alabama, Florida, Nebraska, North Dakota, South Dakota, Tennessee, Utah, Virginia, and Washington.
All estimates taken from "Mineral Yearbooks" of the U. S. Bureau of Mines. Estimates for 1943 and 1944 are not available by states.
†This "includes gas (mostly residue gas) blown to the air, and transportation losses, but does not include direct waste on producing properties, except where data are available" per note in Minerals Yearbook.

of these old shallow wells are familiar with the fact that ratios of 5000 to 20,000 cu. ft. per bbl. or more may actually exist, especially on wells that have a vacuum applied to the casinghead.

● **Kentucky and Louisiana.** The average gas-oil ratio of the oil wells in the State of Kentucky was 911 cu. ft. per bbl. in 1937. The ratio remained about the same until 1942, when it increased sharply to 2139 cu. ft. per bbl. The actual average ratio of the wells in Kentucky certainly didn't more than double in one year. It is more likely that additional data was supplied to the Bureau of Mines, thus enabling the Bureau to make the radically larger estimate of gas produced from oil wells.

The average gas-oil ratio curve for Louisiana indicates a steady increase from 769 cu. ft. per bbl. in 1937 to 1820 cu. ft. per bbl. in 1943. The curve is typical of a gas-drive field, and would not ordinarily be expected in a state with more than 100 oil fields of all types of drives and ages. It is probable that additional data have been obtained on the gas-oil ratio of more of the Louisiana oil fields, thus enabling the Bureau to make a more complete estimate each year.

● **Ohio, Arkansas, and California.** The average gas-oil ratio of the oil wells in the State of Ohio was 899 cu. ft. per bbl. in 1937. The ratio increased steadily to 1139 cu. ft per bbl. in 1940, slumped slightly in 1941, and then increased sharply to 1524 cu. ft. per bbl. in 1942. This increase, as in the case of Kentucky, may reflect a more complete estimate of all the gas produced from oil wells rather than a sharp increase in actual gas production, but the wartime gas demand in that state may have caused a greater effort to obtain gas from the casinghead wells.

The average gas-oil ratio curve for the oil wells of Arkansas fluctuates more than the curve for Louisiana, but the trend is steadily higher. The ratio was only 578 cu. ft. per bbl. in 1937, compared with 1502 cu. ft. per bbl. in 1943. The increase is probably due to the discovery and development of deeper fields during this period, but part of it may be due to inclusion of gas produced from gas-condensate wells. The low ratio in 1937 may be reconciled with the fact that many of the older oil wells were situated in water-drive type of reservoirs.

The average gas-oil ratio of the oil wells in California was 1731 cu. ft. per bbl. in 1937, and remained rather steady until 1942, when it showed a rapid decrease to 1480 cu. ft. per bbl. This was probably due partly to a transfer of some oil wells to the gas well classification, and partly to an increase in oil production from low ratio water-drive reservoirs, but not to a marked reduction of the gas-oil ratio of most of the state's oil wells.

● **Oklahoma and Texas.** It is rather surprising to note that the curve of the average gas-oil ratio of the oil wells of Oklahoma shows a reduction from 1433 cu. ft. per bbl. in 1937 to 1187 cu. ft. per bbl. in 1942. Most of this reduction appears to have occurred during 1941 when the ratio was 1140 cu. ft. per bbl. compared with 1408 cu. ft. per bbl. the previous year.

The average gas-oil ratio of the oil wells of Texas was 764 cu. ft. per bbl. in 1937, and increased rather gradually to 998 cu. ft. per bbl. in 1942. The ratio apparently increased rather rapidly during 1943 to an average of 1179 cu. ft. per bbl. The comparatively low ratio for Texas may be explained by the fact that the ratios in a number of its large oil-producing fields are low. East Texas, for example, has an average gas-oil ratio of only 375 cu. ft. per bbl.

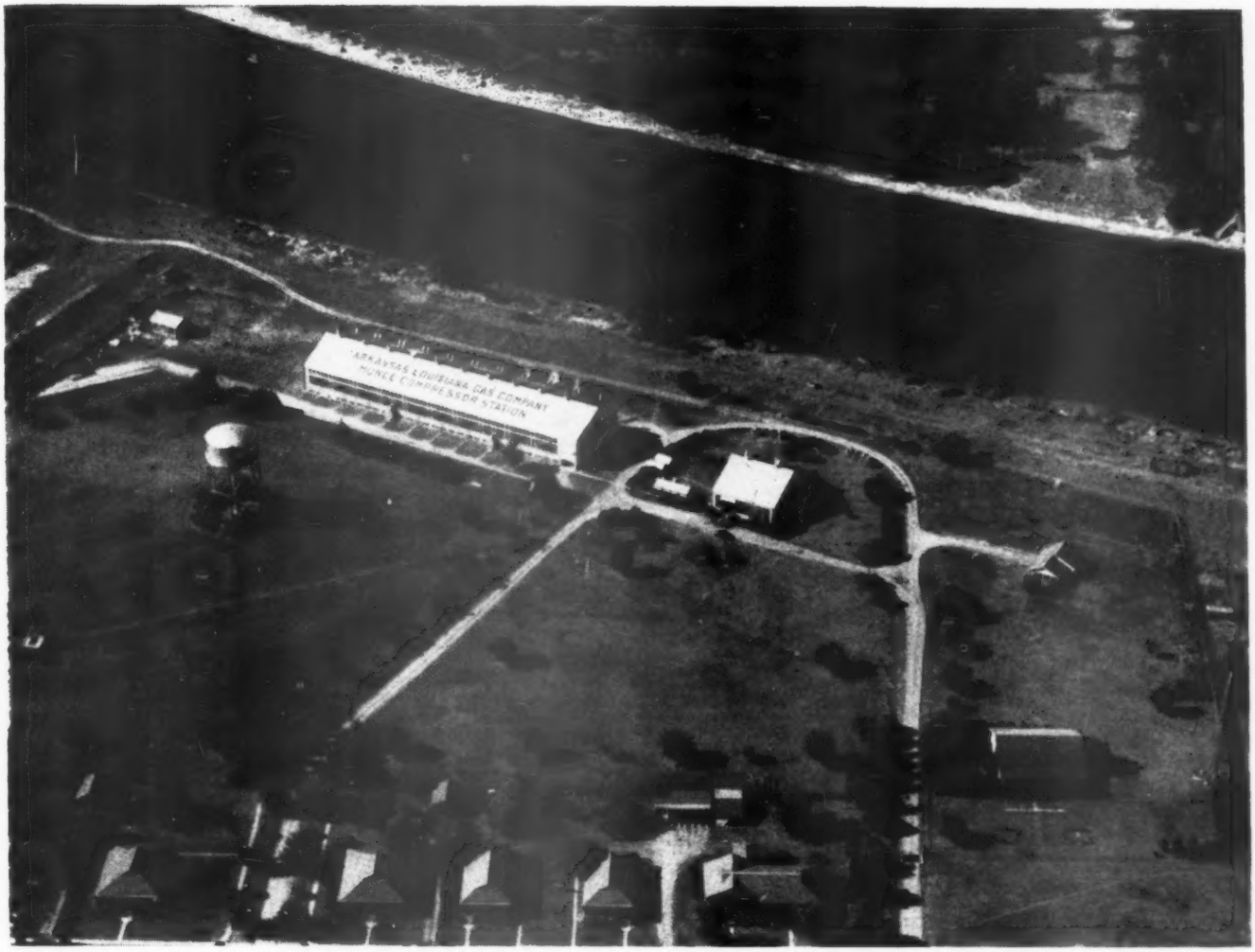
● **Illinois, Wyoming and Kansas.** The average gas-oil ratio of oil wells in Illinois was only 156 cu. ft. per bbl. in 1937. This ratio increased rapidly with the discovery of new fields during 1938, 1939, and 1940 to reach a high in that year of 879 cu. ft. per bbl., and it has not changed materially since that year.

The average gas-oil ratio of the oil wells of Wyoming was 866 cu. ft. per bbl. in 1937, and declined to 692 cu. ft. per bbl. in 1942 from a high of 1035 cu. ft. per bbl. in 1939.

The curve on the average gas-oil ratio of the oil wells of Kansas shows a rather steady decline from a high of 1032 cu. ft. per bbl. in 1938 to 552 cu. ft. per bbl. in 1941. The low ratios in this state are largely due to the fact that the bulk of the oil is produced from water-drive type fields situated in the Arbuckle limestone formation of West Kansas.

● **Other states and conclusion.** Average gas-oil ratio curves are plotted in Fig. 1 for the states of Indiana, Pennsylvania, Colorado, Michigan, and New York. The gas-oil ratios of these states are all below 400 cu. ft. per bbl., according to the estimates made by the Bureau of Mines, but in most of these states the estimated ratios appear to be much lower than they should be, thus indicating that complete data are not available.

In conclusion, the importance of the total annual volume of gas produced from oil wells should be noted by comparison with the volume of gas produced from gas wells (see Table 2). The estimated disposition of all the gas produced is also shown in Table 2. The growth of the repressuring and cycling gas volumes from 84,925 million cu. ft. in 1937 to 755,971 million cu. ft. in 1942 is also noteworthy. ★ ★ ★



Example of a well designed gas compressor station. Note main building location in relation to cottages.

SAFE PRACTICES IN COMPRESSOR STATIONS

By **DON ATTAWAY**
Safety Engineer
Arkansas Fuel Oil Company

EXCLUSIVE

THE equipment required in making up a complete gas compressor station must have constant care and attention if it is to perform efficiently. Frequently inspections are necessary to determine true conditions and immediate repairs made when indicated.

The correction of existing physical and mechanical hazards in gas compressor stations during the last 16 years has been reflected in a greatly reduced accident rate. According to the American Gas Association, the industry has lowered its frequency from an all-time high of 30.5 lost time accidents per million manhours worked in 1929 to a frequency of 14.2 lost time injuries in 1944.

This is a remarkable improvement, yet safety authorities agree that this figure can yet be reduced if more attention is given to the elimination of inherent hazards in construction and unsafe acts on the part of employes.

This article, therefore, is intended to accumulate certain safe practices most generally accepted by construction engineers, designers, safety men, compressor manufacturers, and operators in the installation and operation of a gas compressor station. Such safe practices are not to be confused with state and federal laws or regulations.

● **Building and location.** It is important that compressor station locations be correctly made and that engines and lines be properly placed. The choice site is usually on the downwind flank of an elevation.

The compressor building should be situated so that prevailing winds give it ample draft and ventilation. The building should be of steel frame construction. Wood and inflammable material should be excluded so far as possible.

Windows should open outward and exit doors should be located for easy quick exit. The general rule is at least one door for each two units after three installations. Two windows for each unit are desirable for proper light.

Adequate ventilators should be placed on the building ridge and openings made at floor level to encourage air circulation. Heavy gases tend to collect at floor level and create an explosion hazard.

● **Foundations.** The base for all engine foundations should be a mat extending under and beyond all compressors, unless resting upon solid rock, in which case some dampening material such as cork should be used for insula-

tion. No connection between the engine and the building foundation should be used as vibration may be transmitted that will weaken or break piping.

Basements are desirable on large main line stations and should be built high enough to provide ample head room and working space around piping. The open storage of oil or waste in the basement is not good practice.

● **Inlet and outlet piping.** A great hazard in a compressor station is the possibilty of fluid entering the compressor cylinder. For this protection, gas cleaners or scrubbers must be installed on the suction lines to remove foreign matter such as dirt, scale, and liquids. Each scrubber should have a liquid-level alarm and an ample drain. Frequent inspection and draining of the scrubber is important.

The suction and discharge piping is preferably installed aboveground for easy inspection and repair. Cat walks are valuable above the piping.

Valves of the lubricated plug type are desirable, but all valves should be kept leakproof by proper attention to packing glands and stems. Remote operated valves with control points at a safe distance from danger areas are good practice.

Adequate relief valves with discharge opening piped high enough to competely dissipate gases are necessary. Such valves should have drain holes at the low point to prevent water standing over the relief valve seat.

Inlet and outlet lines should have indicating pressure gages at some point outside the building in addition to the usual recording gages on the control board.

● **Fuel system.** A constant supply and quality of dry clean fuel gas of about 1300 B.t.u. is desirable. Use of blended waste gas of heavy fractions results in "rough" engine detonation and affects piston and bearing wear and produces unsafe conditions.

The use of one large pilot-operated reducing regulator is considered safer than small individual less active regulators.

● **Water system.** The lack of clean scale-free cooling water has wrecked more gas compressors than any other one thing. Water supply sources having undesirable calcium and magnesium compounds, excessive oxygen content, and algae should be chemically treated.

Safe practice is to hold the temperature difference on incoming and outgoing water at 20°F. or less to prevent undue cylinder head strain and piston seizure.

The closed cooling system is generally preferred to the open system, which accumulates mud and sludge in daily make-up water and absorbs oxygen through the cooling tower thus adding to corrosiveness.

Adequate circulating pumps are necessary for closed systems and the most reliable circuit is where suction is taken from the standpipe and discharged through the heat exchanger and engine back to the standpipe, which should have a vent to atmosphere so constructed that only a minimum of water surface is exposed to the air. The return line from the engines should enter well below the normal water level, but high enough to produce an upward slope from engine to tank.

Piping from the pump discharge should have an upward slope, but design often prevents this so an automatic air vent should be installed on the high point in the line.

Best practice in open cooling systems is to have two sets of pumps, one circulating water to the engines and the other picking up warm water and discharging over the cooling tower.

Each compressor requires a separate pump for fire protection service to station and cottages as the plant system pressure is usually too low for fire-fighting purposes. For safety, such a pump should deliver at least 50-lb. pressure with a capacity for two standard fire hose streams.

● **Lubrication.** Improper lubrication will cause serious damage to cylinder walls, bearings, and rods. Even explosions are possible. The first rule is to follow the specifications prescribed by the compressor manufacturer. Various gases have a high affinity for oil, leaving the cylinder walls dry and creating an unsafe condition.

The cooling water should be kept at a temperature near that of the incoming gas to prevent condensation on the cylinder walls, thus cutting the lubricating oil.

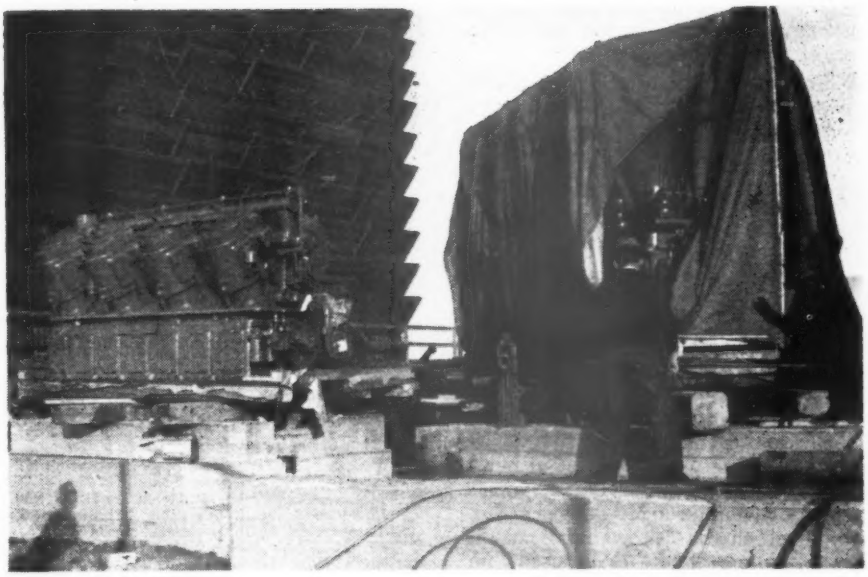
Oil coolers are best served by a water system separate from the main engine supply. Tube bundles in these coolers should be cleaned at regular intervals.

It is poor practice to operate without some type of oil filter. Regardless of the selection, the economy and safety obtained are well worth the installation cost.

Operators and oilers handling oil should bear in mind that spilled oil must be wiped up immediately and that compressors should not be lubricated manually while they are in motion. Operators and repairmen should never use kerosine, gasoline, or light petroleum products in flushing crankcases or cylinder. They are volatile and therefore dangerous.

Care should be taken not to use rags

Typical example of a well located compressor station. Note adequate ventilators, exits, and windows opening outward. This station is located on the downwind flank of a slight elevation.



Proper foundations for compressors are important to safety of the station.

or waste that leave a lint deposit that may clog oil lines.

It is a good practice, when installing or filling lubricators, to break the oil line joint nearest the cylinder and crank the lubricator by hand until oil appears.

● **Ignition system.** It is an unsafe practice to remove wires from spark plugs while engines are in operation.

Spark plug life is prolonged if the ignition system is a low tension magneto with a rotating field and a high tension coil at each plug. The rotating high tension magneto is a good selection also but it has a corona loss in transmitting the spark over lengthy wiring.

A good practice is to clean and adjust spark plugs at least once each month.

● **Air cleaners and exhausts.** The air cleaner is required protection against dust and foreign matter that may be carried into the cylinders. They should be installed high enough above ground to prevent dirt and grit being sucked into them. The oil-bath type is very satisfactory and acts as a silencer and may even be installed indoors under safe conditions. The air cleaner should be inspected at least twice a year.

The air-cooled exhaust has largely replaced the water-cooled type and permits the installation of heat ducts by which the main building may utilize the waste heat. Such exhaust should be guarded against accidental personal contact.

If water-cooled exhausts are used, they should be so situated and elevated that flying spray or mist will not obstruct working areas or contact personnel or buildings.

● **Safety devices.** Most modern compressors are originally equipped with a number of safety devices and all compressors can and should be fitted with such controls.

All flywheels should have an overspeed trip for automatic shutdown to prevent flywheel explosion in case of a governor failure. This device should be tested at least every six months to insure its operation.

Engines should be equipped with a low-pressure oil and a high jacket water temperature shutdown device. Failure in either of these conditions may result in a serious accident.

A new and worthy safety device is the alarm for showing abnormal pressures on the compressor manifold.

● **Starting and stopping.** Numerous accidents occur in starting and stopping and operators must follow definite safe practices in operating compressors. Before any unit is started it should be thoroughly checked for loose mechanical parts and forgotten tools. This can be done by turning the engine over by hand a few times. The discharge gate must be examined and placed in open position. Fuel should not be admitted before the ignition is turned on as the engine rolling under air starting may cause fuel gas that will explode to collect in the exhaust system.

The compressor should be stopped by shutting off fuel first and ignition next and allowing the flywheel to come to a full stop before operating suction or discharge gates.

Operating compressors behind pinched gates is not good practice.

Any compressor knocking or producing strange noises should be shut down immediately for inspection. Too often, a compressor operating strangely and giving warning that something is wrong, is allowed to run and serious damage results.

● **Mechanical maintenance.** To repair compressors properly, correct and adequate tools are required. Each station should have a tool board or rack for this equipment. The safe rule is to use the right tool for the job in the correct manner and keep the tool in good condition. Tools should always be returned to their regular place after use.

The safe operation of compressors depends largely on their care and repair. A heavily loaded unit may require an overhaul as often as each six months. A light load and slow speed unit may only require repair every four years. The angle type unit should be overhauled at least once each year. The overhaul should include:

1. *Free piston rings and remove carbon from groves, piston body, and exhaust ports.*
2. *Change or reface valve guides and seats.*
3. *Check main and rod bearings, wedge bolts, tie rods, and yokes.*
4. *Clean crankcase and jackets, intake valves, governor, and fuel mixer.*
5. *Micrometer the cylinders and record wear.*

The repair crew should include at least six men to provide ample manpower and reduce time out of service. One

Interior of modern gas compressor station showing full window lighting and overhead traveling crane.

man should be directly in charge of the crew to outline work and maintain uniform operation.

The station should have an overhead crane or hoist of not less than 2-ton capacity to eliminate heavy and bulky lifting.

Adequate extension lights in good condition should be available at all times.

● **Fire protection.** Sources of ignition must be eliminated around compressor stations as inflammable vapors are more or less present at all times. Oily wiping rags and waste should be kept in a closed metal container.

Each station should have at least two large dry chemical fire extinguisher carts situated at opposite sides of the station. Carbon dioxide or dry chemical hand extinguishers should be mounted inside near the door of every fourth unit.

Foam extinguishers should be placed near oil storage and protected from freezing.

Adequate fire-fighting equipment may mean the difference between a disaster and a small fire. All employes must be instructed in the proper use and operation of fire exinguishers.

● **General.** Undoubtedly safety and good operations go hand in hand, therefore regular safety meetings should be an operating part of each stations schedule.

Certain of the compressor station duties are of such a nature that the employe requires special protective equipment. Some of the equipment that should be in every station is a gas-testing explosion device, non-sparking tools, gas masks or respirators, goggles, salt tablet dispensers, and safety shoes.

Protective equipment is of no value unless it is used and men should be instructed and encouraged until they have formed the safe practice habit of never attempting work involving a hazard without personal protective devices. This equipment should be available at the point it is most likely to be used; for example, the goggles belong at the tool board and grinder. The non-sparking tools should be properly marked and designated on the board.

Each station should have a well filled first aid cabinet and all employes instructed in first aid. Even the slightest cut or bruise needs attention.

Modern compressor stations vary in size and capacity and many unusual and ingenious devices and designs may be found. In view of such a condition, all the safe practices cannot be listed here but those outlined are applicable to the general type and their adoption and use will result in a more efficient operation, a safer working place, and better employe morale.

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International Petroleum Exposition Scheduled for 1945

THE International Petroleum Exposition will be resumed in the spring of 1947, with the dates for the first postwar show being set for May 17 to 24, inclusive, it is announced by W. G. Skelly, president.

Dates for the exposition were selected by the executive committee after a poll of previous exhibitors in the show. The

W. G. Skelly, President

last exposition was held in 1940, the 1942 show having been cancelled because of the war.

"We have contacted every exhibitor of previous years, and they have overwhelmingly expressed a desire to resume the International Petroleum Exposition in the spring of 1947," Skelly said. "General opinion among the exhibitors was to make the next exposition the largest ever held, and the majority felt it would take nearly 18 months to plan and prepare their exhibits for the exposition."

The Tulsa exposition, which was first held in 1923, has grown to be one of the largest single-industry expositions in the world, and has not only been represented by nearly every major oil firm and associated industries, but has attracted huge exhibits and delegations from foreign countries.

The 1947 exposition will have even more foreign countries represented than in past years, it was indicated by Skelly.

"We have already received several queries from foreign countries about the dates of the next International Petroleum Exposition," Skelly said. "These are in addition to foreign exhibitors and delegations of previous years. The development of foreign fields, greater recognition to oil producing countries, and the necessity for cooperation in locating and developing these new fields will be of primary importance in the 1947 exposition.

"Our South American neighbors are playing an increasingly important part in the world's petroleum industry, and many new opportunities for development are being realized by them. At the same time, many valuable oil fields of the world were destroyed during the war. Reconstruction of these fields in the immediate future is imperative. The International Petroleum Exposition will be an invaluable aid to representatives of these countries in future development of their resources.

"The executive committee authorized William B. Way, general manager of the International Petroleum Exposition, to proceed immediately with plans for the next exposition.

"Our greatest problem in the 1947 exposition will be finding space to take care of the exhibitors," Way told the executive committee. "In our last show all the space was sold, and we turned away many possible exhibitors. With the growing interest in new development, and the large quantity of new equipment that will soon be on the market, the accommodation of exhibitors will be a major problem.

"Our exposition plant, which includes 50 permanent buildings and nearly a half million feet of floor space, will be

W. B. Way, General Manager

far inadequate to take care of the actual needs for such an exposition."

Members of the executive committee who attended the recent meeting included Skelly, Alf G. Heggem, vice president of the Oil Well Improvement Company; Frank J. Hinderliter, president, Hinderliter Tool Company; W. M. Bovaird, president of the Bovaird Supply Company; Frank O. Prior, president of the Stanolind Oil and Gas Company; Clyde H. Pape, oil operator, and Way.

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PETROLEUM RESEARCH GOES ELECTRONIC

By **RICHARD SNEDDON,** *Pacific Coast Editor*

EXCLUSIVE

ONCE at a movie show we saw a close-up of Dr. Jekyl drinking his mysterious potion, whereupon, before our very eyes, his features contorted, swam into a confused blur—then, gradually reassembled and stabilized in completely new form and character. We are reminded of that demonstration every time we enter a petroleum research laboratory, where weird gadgets and contrivances, conjured in the uninhibited minds of chemists and physicists, are subjected to such a continuity of adaptation they seem to be convolving while one looks at them. For years we have watched, fascinated, while trends in petroleum process and product have been defined and directed in advance by the metamorphic wizardry of research.

It is doubtful, however, if in the exciting field of scientific exploration among the hydrocarbons, and the other incidentals of petroleum producing and refining, there has ever been anything more demonstrative in the way of evolutionary development than the current swing to electronics. After an absence of several years, we traveled down to Wilmington recently and dropped in on Don Carr and his sizeable corps of scientific aides at Union Oil Company's research laboratory, just to see what was going on. We found the institution vastly changed, almost unrecognizable, indeed—it had a queer futuristic appearance, a sort of "Amazing Story" magazine look, obviously springing from the strange array of modernistic machines, marshalled under the supervision of Lawton Beckwith, to probe the mysteries of molecular structure, association, and reaction.

This immediately noticeable trend in the direction of electronics is more revolutionary than evolutionary; at least, it was so accelerated during the war years that it just seems to have "growed," like Topsy, without benefit of forebears. Even the pilot plant laboratory with its juvenile cat crackers and superfractionators, reaching high into the rafters, had a predecessor. Back in the old days, in a pit behind the research building we used to build Goldbergian assemblies of pipes, tanks, and valves, to prove or disprove the prevailing theory and to lead the way to the still more complex contraptions of today. But there was little in the category of process or equipment that, looking back even now, could be considered a step toward electron microscopy, mass spectrometry, emission spectroscopy, infrared absorption, or X-ray diffraction.

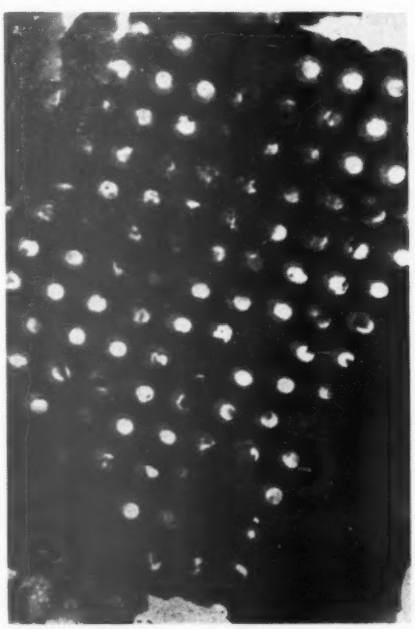
These latter methods of analysis constitute a completely new departure from the laboratory routines of yesterday, yet already they, too, have almost become routine. Certainly, the tedium of wet analyses, the inaccuracy of thermal fractionation and the inadequacies of many commonly used analytical systems are being rendered of little concern by the speed and precision of electronic devices. It is also to be noted that the latter are frequently employed with decided advantages to complement prevailing test methods, in many instances promoting more complete and accurate analyses with considerable saving of time.

In addition to their time-saving virtue, these physical tests usually require much less sample than do chemical methods and in some instances produce results on the basis of a measurement or series of measurements that neither disrupts nor dissipates the sample, at least to any appreciable extent. And, while the particular electronic methods mentioned here have their application mostly in control analysis and other laboratory functions at the present time, there is little doubt that in due course some of them will be adapted to continuous operation on such a scale that they may become factors not only in process control but in the very process itself.

● **The electron microscope.** Of especial interest among the group of electronic instruments now to be found in Union Oil Company's research department is the electron microscope, presenting something ultra in the matter of magnification and providing a medium for the study of particles so minute as to be beyond the range of any other type of microscope. This device, instead of a beam of light, uses an electron beam to illuminate the specimen, and because of the extremely short wave lengths of this beam (1/100,000, the wave lengths of visible light), resolves or defines in unusual clarity items much too small to be captured in detail, if at all, by any optical instrument utilizing a light beam even if the magnifying power of such an instrument were just as great. In actuality, however, the electron microscope yields useful magnifications fifty times greater than can be acquired with the highest power light microscope.

The mechanism of the process is briefly as follows: A stream of electrons from a hot cathode flows at high velocity through an annular coil whose field bends them into a parallel beam that is directed on the specimen under examination. Those rays that pass through the specimen are focused by the field of a second coil and form an enlarged image. A small section of this image is similarly projected, further magnified by the field of a third coil, and finally becomes visible on a fluorescent screen. Photographs of this projection are made by simply allowing the electron beam to fall on a sensitized plate. In this manner mag-

Diatomaceous earth as it looks when it is magnified 100,000 times, more or less, on the electron microscope.



Alpha alumina monohydrate crystals magnified approximately 35,000 diameters on the electron microscope.

W. C. Merrill checks the controls on an RCA electron microscope. This amazing device with the aid of ordinary photographic enlargement produces magnifications of approximately 100,000 diameters.

nifications in the neighborhood of 100,000 times are achieved and the artificial eye of the chemist becomes some 50 times more penetrating than it was a few short years ago. Maximum magnification on the plate itself is 20,000 diameters. Projection of a photographic enlargement of the plate yields further resolution up to about 100,000 diameters. Magnification beyond this, while entirely possible, adds nothing and is thus called "empty" magnification.

What benefits may eventually accrue to the petroleum industry from the use of the electron microscope it would be difficult to predict but there is no question that the device holds great promise. Slowly but surely it is helping to bring into view infinitesimal worlds that have long been known to exist but have so far remained beyond the scope of even amplified vision. It is searching out, with its remarkable focal depth and great power of magnification, structural peculiarities and hidden characteristics, certain knowledge of which opens the door to great new avenues of scientific progress. It seems logical to believe, further, that it will eventually expose the mechanisms of many reactions at the moment little understood. The future of the petroleum industry is dependent in a large measure on our growing understanding of the true nature of structural differences, particularly in the hydrocarbons, and of the *modus operandi* of such mechanisms as isomerization, polymerization, catalysis, etc. The electron microscope may be expected to aid greatly in developing fundamental data relating to these abstruse phenomena and so lead the way to the manufacture of many new, useful products from crude oil.

● **The mass spectrometer.** A great deal has already appeared in the literature with respect to the mass spectrometer and perhaps it is unnecessary here to describe the device or its function in detail. Despite the fact that it has in a very substantial way already justified its acceptance by the petroleum industry, however the prospective diversity and range of its applications are so great that this treatment would be incomplete without an exposition of its usefulness.

Briefly the machine consists of a sample inlet, an ionization chamber, an analyser tube, and a recording system. The sample, as little as a tenth of a cubic centimeter, is introduced via the sample inlet to the ionization chamber where it is bombarded *in vacuo* with electrons from a glowing filament. This has the effect of ionizing, or ionizing and fragmenting, the molecules in the mixture, which, by means of a difference in electric field then pass at high velocity into the curved analyser tube. Here their respective paths are influenced by a magnetic field, that is, the ionized particles are deflected more or less, according to their mass, so that they are segregated into individual streams or "ion beams." These beams are made to pass through a narrow slit and impinge on a collector plate, where after amplification they are measured by a series of galvanometers, the deflection being recorded photographically.

The result is a spectrum, which under any specific set of conditions remains constant for the same compound or mixture of compounds. Each gas has its own definite and distinctive spectral pattern, and to make the process still more elastic and generally useful, the spectrum of a mixture of gases is the sum of the spectra of its components. Thus, having by test runs established the spectra of a number of pure hydrocarbon gases, it becomes a comparatively simple matter to calculate from the spectrum of a mixture, the content of each component. By this means, mixtures of as many as 22 components have been successfully and accurately analyzed and experimentation with increasingly complex mixtures is being carried on daily.

It will be immediately obvious that the mass spectrometer lends itself admirably to the detection of impurities, since under standard conditions any deviation from the normal spectrum would at once indicate some change in constitution whether a single gas or a mixture of gases were under examination. Incidentally, the pattern is so distinctive that the machine readily differentiates many isomers, and readily distinguishes most of the gaseous hydrocarbons, no matter how closely related or how similar otherwise they may be. By virtue of its keen sensitivity the future of the mass spectrometer as a research instrument is fully assured.

● **The emission spectroscope.** It has been long known that if a substance be burned the character of the light emitted can by spectroscopic examination be used to determine its composition. When the conditions of burning and observa-

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Ed Mount introduces liquid sample into the mass spectrometer.

tion are closely controlled the atoms of an element exhibit a characteristic light that appears when the electrons in the atom are so disturbed that they change energy levels. This species of excitation is contrived in the case of most elements by thermal or electrical energy supplied by a flame, arc or spark. A few elements do not react to the same treatment but have to be excited by ionization in a gaseous discharge.

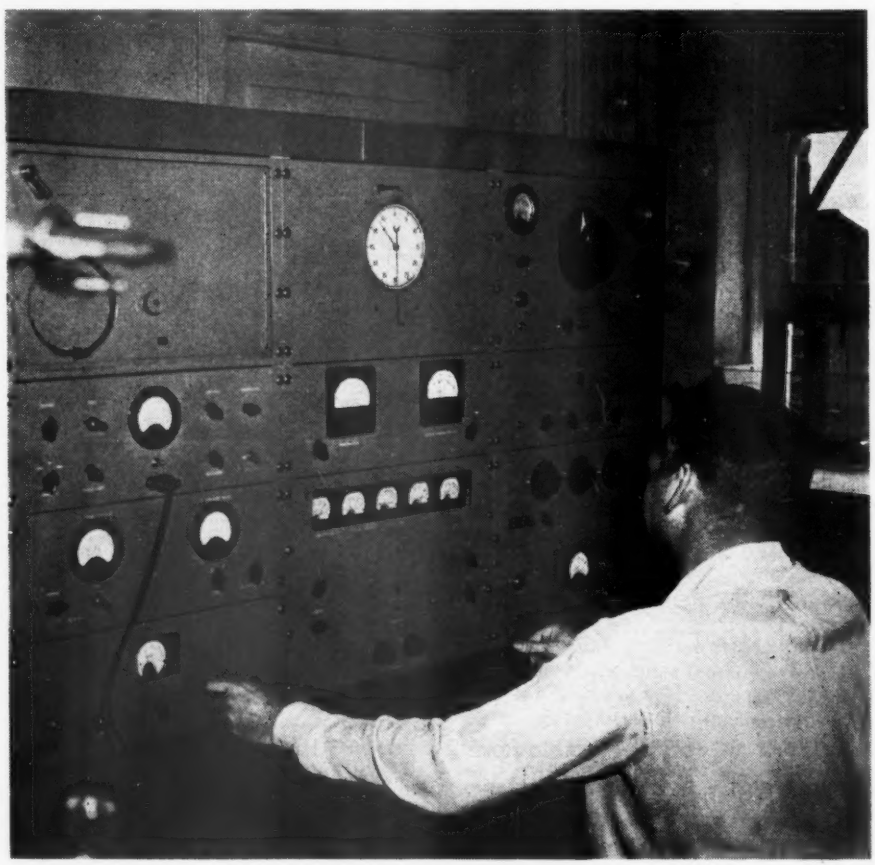
The method, however, is at the moment primarily adapted to the positive identification of metals and metalloids, which it does with remarkable accuracy, even in the lowest concentrations. Most of the metals can be quickly identified when only a few parts per million are present in the sample. Such elements as sodium, potassium, and lithium are difficult to determine by chemical means, but are easily and quickly defined by the emission spectroscope, and it has been said that no metal has yet been made of such refinement that the spectrograph couldn't find in it some measure of impurity.

In order to preclude any erroneous conclusion, it should be emphasized here that this particular species of spectrochemistry is not only amazingly positive in a qualitative sense but is also capable of making fast and accurate quantitative determinations of a considerable number of elements in a wide variety of compounds and mixtures. Actually, the process consists of vaporizing the sample either by the use of intense heat or electric bombardment. In this way it is decomposed into atoms, which by the use of a sparking or arching device are made to give off light, consisting of a number of wave lengths distinctive of each kind of atom present in the sample.

When this light is dispersed in a spectrum the characteristic lines of many elements appear, which, of course, facilitates their easy identification when compared with standard spectra. The intensity of this light depends on the number of atoms present in the beam, so that when the intensity of certain key lines in the spectrum is measured, a quantitative relationship can be coincidentally established. For adequate dispersion, independent of wave lengths, a precision grating is used and a camera is available to make the necessary photographic record. The optical density of the significant lines is measured on a densitometer and compared with those from known samples of approximately the same composition.

The Applied Research Laboratories have been successful in building direct-reading instruments for certain more or less routine analyses in which the components of the sample under test are known. For example, one such instrument is capable of determining the percentages of six components in an alloy steel, yielding accurate results directly in a very few minutes. At the moment there seems to be no early prospect of developing a direct-reading instrument for general analytical work, but—it

At the control panel of a mass spectrometer is W. J. Harbert. Consolidated Engineering Corporation has developed an electric computer that still further reduces the already short time required by this apparatus to analyze many complex hydrocarbon gas mixtures.



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takes a pretty complex problem to stump a group of physicists in these times.

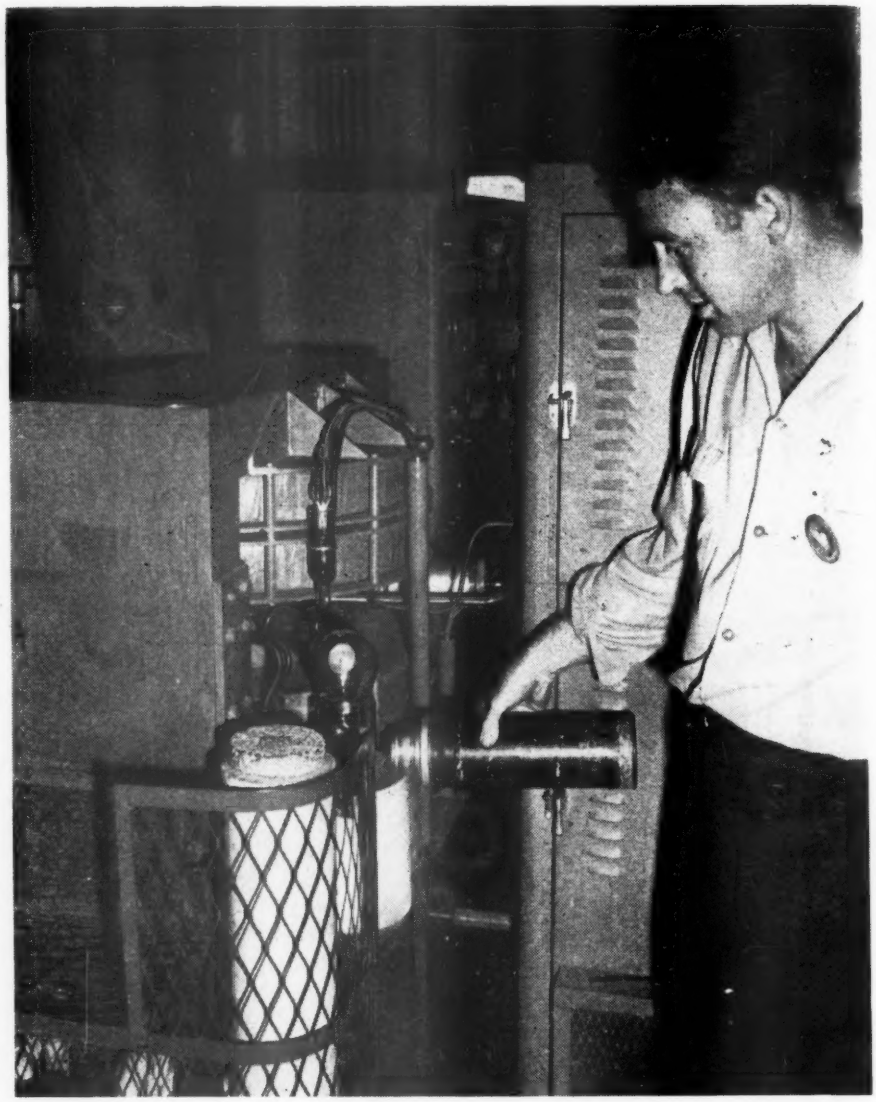
Some work has been done with the emission spectrograph on the correlation of oil well waters, the samples first being evaporated to dryness and the residue, after fusion in a platinum dish, being arced with a high voltage a-c. arc unit. The spectrogram is then placed in the projector-comparator-densitometer, the various groups of elements are defined, and the intensity of the lines determined. Being usually the major constituent, the sodium line is taken as the criterion and the relative intensities of the other elements are calculated. The figures thus obtained are the basis of a series of variables, (ratios) which may be used in the subsequent statistical treatment. With such variables established for well waters from various zones in the same field, the most diagnostic are selected and used to define the source or sources of unknown samples. The method appeared to be effective not only for the correlation of well waters but also for cores.

In the control of refining processes the emission spectroscope is employed in the examination of catalysts for traces of metals. It appears to be more accurate than any other known method for the determination of low concentrations of metallic elements and in some instances the time saving is very great. Like most of the other electronic analyzers, this instrument has special appeal in the facts that within the limits of its application it is speedy and accurate, and simple of operation.

● **X-ray diffraction.** The most popular function of the X-ray diffraction instrument is the study of crystalline substances. Because the distances separating the elemental particles of a crystal are of the magnitude of the wavelengths of an X-ray beam, it is possible to develop diffraction patterns of crystalline substances that for each form are just as distinctive as the other spectral patterns that have so far been discussed. The identification of various inorganic depositions on internal combustion engine parts, such as pistons, valves, bearings, etc., is one practical application. The instrument, however, lends itself to a wide range of analytical problems in metallurgy and metallography, in both general and physical chemistry, in the process industries, in mineralogy and in physiology, pathology and biology.

It would seem from already recorded experience that distinctive data relating to the submicroscopic structure of almost any sort of material can be acquired by X-ray diffraction, so that much of what was formerly inferred is now being proved by actual evidence. Diffraction characteristics are used for such eminently practical purposes as to determine the structure of welds, the uniformity of surface hardening, the nature and degree of corrosion or thermal fatigue in metals, and the effects of minute impurities upon their structure.

In chemistry, it is used to estimate the relative amounts of the various compounds in a mixture, to determine crystal and colloidal sizes, to determine porosity, to discover unsuspected chemical reactions, to determine molecular weights of liquids, to estimate molecular weights of hydrocarbons, to study polymerization and condensation reactions, and decomposition in breaking of long chain compounds, and to study lubrication and lubricants. There is actually in effect a diffraction method of quantitatively comparing the efficiencies of lubricants.



Dewitt Roberts is adding liquid nitrogen to the cold trap on the mass spectrometer.

The atomic building blocks in the compound or mixture under test are diffraction centers, and crystalline material thus, in effect, becomes a diffraction grating for an X-ray beam. The measurement of diffraction intensity is made by means of an ionization chamber and amplifier system. The ionization chamber is supported on the base of a goniometer and is adjustable so that it may be set at the proper angle for the specific type of cut or angular determination. The reading of the intensity of the diffracted X-ray beam from the sample crystal face under examination is made on a meter or it can be recorded photographically.

In the petroleum laboratory, it can be seen from the examples already cited that X-ray diffraction is an instrument that has great potentiality both for the speeding of routine control work and for complementing the many other analytical processes now in use. It has been stated that approximately 95 per cent of all inorganic materials yield a diffraction pattern by means of which they may be identified. Taking into consideration, also, extensive application in many phases of organic chemistry, there can be no question that X-ray diffraction will become a growingly important analytical tool in the future of petroleum research.

● **Infrared absorption.** The phenomenon of infrared absorption adds another valuable unit to the formidable array of electronic devices, so-called, that are now helping greatly to solve the mysteries of the molecular. The sensitivity of this medium is largely due to the fact that in the spectrum of electro-magnetic frequencies, the range from 1 to 30 microns, that is, the infrared area, corresponds closely to the vibration frequencies of atoms or groups of atoms within the hydrocarbon molecule. At any given temperature the atoms in a molecule oc-

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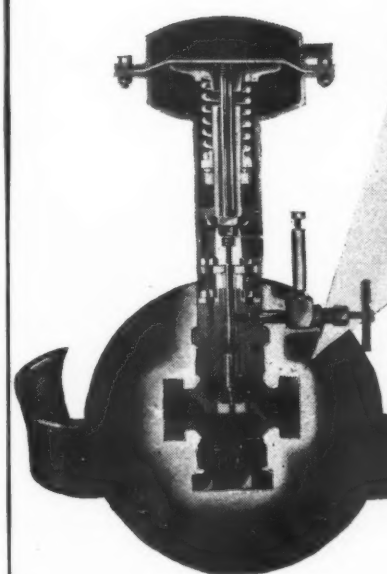

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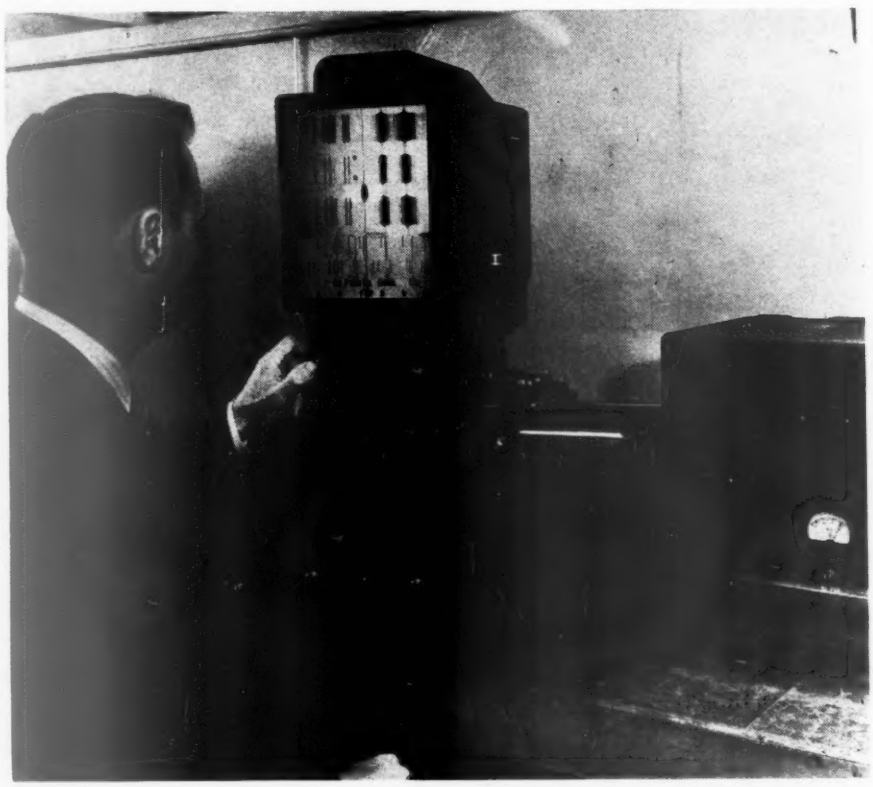
Another of the ultra modern devices now serving the petroleum research and development laboratories is seen here. Mrs. J. Cartmel is adjusting the camera on a GE X-ray spectrograph.

This operator is determining the relative density of significant spectrum lines on a comparator densitometer.

cupy equilibrium positions in relation to each other and are in a constant state of oscillation about these positions. The frequency of such oscillation, for the hydrocarbons, falls somewhere within the frequency limits already mentioned. As any infrared active material will absorb radiation to a constant degree for any specific set of conditions, we have here the basis of another method of analysis.



The infrared spectroscope very readily and quickly identifies such difficultily separable hydrocarbons as heptane and isooctane, and, indeed, is unusually sensitive in its definition of all hydrocarbons, gaseous, liquid and solid. It is useful for qualitative and quantitative analyses of hydrocarbons where the number of components is limited—say, below ten. Thus it is not of much value for liquids above the gasoline range, nor for solids. In spite of the difficulties involved, it is performing excellently for the petroleum chemist, in the study of structural significance and other pertinent matters related to a diversity of refining processes. It can be used, for example, to determine mercaptans in base gasoline stocks and in other routine control tests. Its great potential, however, is in the study of junctional groups within the molecules and the identification of the molecules themselves.

We have attempted to give a superficial account of just a few of the effective and exceedingly interesting contrivances that are now rapidly altering the investigational approach of the petroleum industry. These strange new machines are all based on one simple fact --that under a sustained set of pertinent conditions a physical phenomenon remains the same in character and effect. They provide a completely new approach that is tremendously revealing. For, Union Oil Company, as for many other forward-looking organizations, they have accelerated the accumulation of "know why" that process engineers will later convert into "know how." At this moment we are undoubtedly going through a transition period in the history of petroleum research that is fraught with the greatest significance.

In retrospect it is all very entertaining. There was a time not too long ago when chemistry was chemistry and physics was physics and never the twain were expected to meet. To the chemist, the physicist was an abstract sort of lad with thick-lensed glasses, who knew all about latency, adsorption, resonance, hysteresis, and other obscure phenomena. He was so intent in his own ethereal little world that he didn't have too much time for the trials and tribulations of the mere chemist. On the other hand the chemist, so far as the physicist was concerned, was every whit as individualistic and aloof. With rumpled hair and acid-stained hands, he maintained his avid search for the elusive radical. Dimly in the back of his mind he realized that there were such things as physical laws—but they were definitely to be avoided—certainly, not cultivated. Gradually, however, down through the years interests merged. There was no chemistry without physics. No physics without chemistry. Now, inseparable and indispensable, each to the other, they march together, blazing a trail that will guide the petroleum industry into realms of enterprise such as the wildest fictionist never dreamed. ★ ★ ★

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HYDRAULIC TORQUE CONVERTERS and COUPLINGS

By NICHOLAS A. D'ARCY, JR.

HYDRAULIC torque converters and hydraulic couplings are working in all branches of the petroleum industry from the geophysical surveying rigs to the shipping department of the refinery. New applications are being developed with regularity. These two types of hydraulic units each reduce shock loads on equipment, absorb torsional vibration, prevent stalling of the prime mover, and simplify control of equipment. Although hydraulic drives have many advantages and produce many successful installations they should not be applied without making a thorough engineering study of each individual application.

EXCLUSIVE

N. A. D'Arcy, Jr.

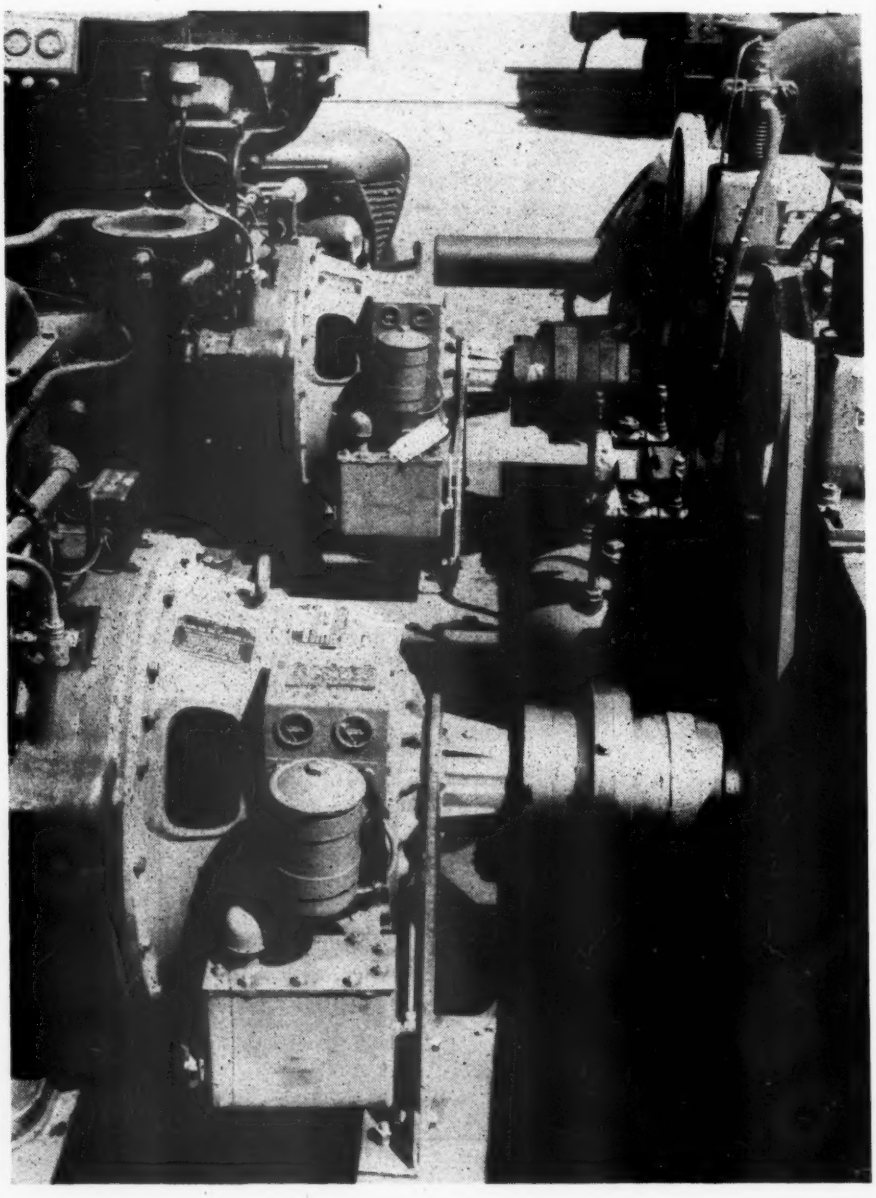
● **Principle of hydraulic torque converters.** Hydraulic torque converters are hydraulic turbines capable of developing output torques from zero to five times the torque of the prime mover. The output speed of the converter can vary from full engine speed to zero but it is recommended that output speeds be maintained between 75 and 25 per cent of input speed for most efficient operation. Converters are intended to operate on installations subject to frequent starting and stopping under differing speed and torque requirements. The prime mover is generally operated by the throttle and all clutches are engaged before the prime mover is brought up to speed. The torque converter picks up the load smoothly and transmits the required torque to the balance of the drive. This hydraulic drive acts as a transmission with an infinite selection of speed and torque within its operating range.

The torque converters now in commercial production consist of a centrifugal pump, or impeller, two sets of stationary reaction blades in the housing, and three sets of turbine blades on the output shaft. The impeller imparts kinetic energy to the fluid in the closed system. This energy is delivered to the turbine blades and the stationary reaction blades assist in redirecting the flow of the fluid to the second and third stage turbine blades. The reaction and turbine blades are similar in appearance to a conventional steam turbine and the impeller is similar to a conventional centrifugal pump. The torque converter is not reversible and the turbine blades cannot be used as the driving member.

● **Principle of hydraulic couplings.** Hydraulic couplings consist essentially of two similar opposed vaned members. Either member can be used as the driving member and the coupling can be reversed without any complications. As the two members are similar it is natural to expect that the power transmitted would be similar to the power delivered to the couplings and this is true. Hydraulic couplings always trans-

(Continued on Page 72)

Drawworks engines equipped with torque converters reduce maintenance on rig and increase ease of handling hoisting loads.



*Nicholas A. D'Arcy, Jr., received his engineering education at the California Institute of Technology and is a member of AIME. He is a partner of the Charles W. Carter Company, Los Angeles, specializing on the installation of friction clutches and hydraulic drives in the petroleum industry. He has been connected with the oil industry since 1929 when he was manager of the San Joaquin Valley division of the Consolidated Steel Corporation of Los Angeles.

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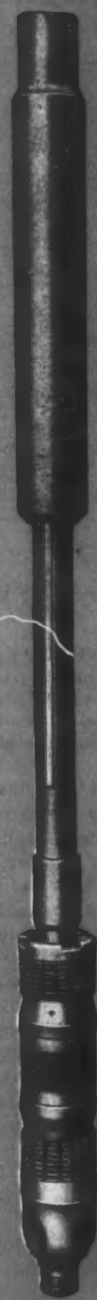

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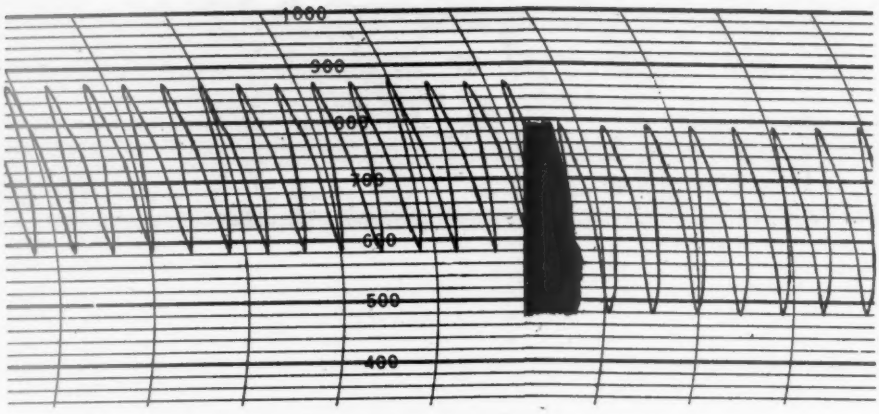
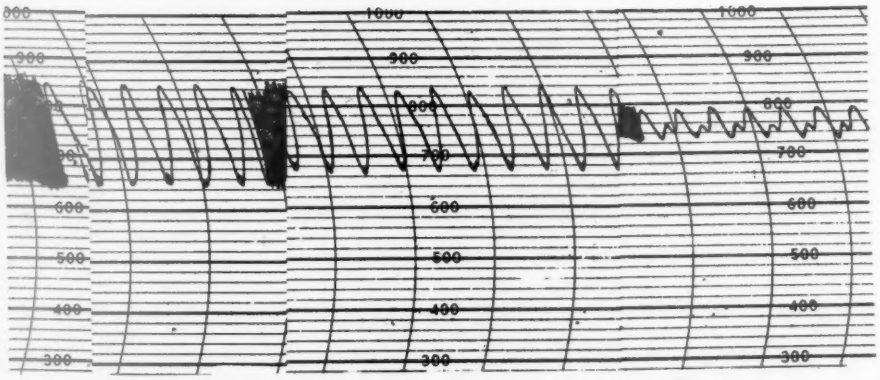


Friction clutch on engine. 120 to 143-lb. pressure. Left—22.2 strokes per min. Right—19.4 strokes per min.



Hydraulic coupling on engine. 22.4 strokes per min. Left—105 to 115-lb. pressure. Center—132-lb. pressure. Right—200-lb. pressure.

ENGINE SPEED VARIATION. Comparison of pumping unit engine speed variations per stroke of the unit before and after hydraulic coupling was installed on engine.

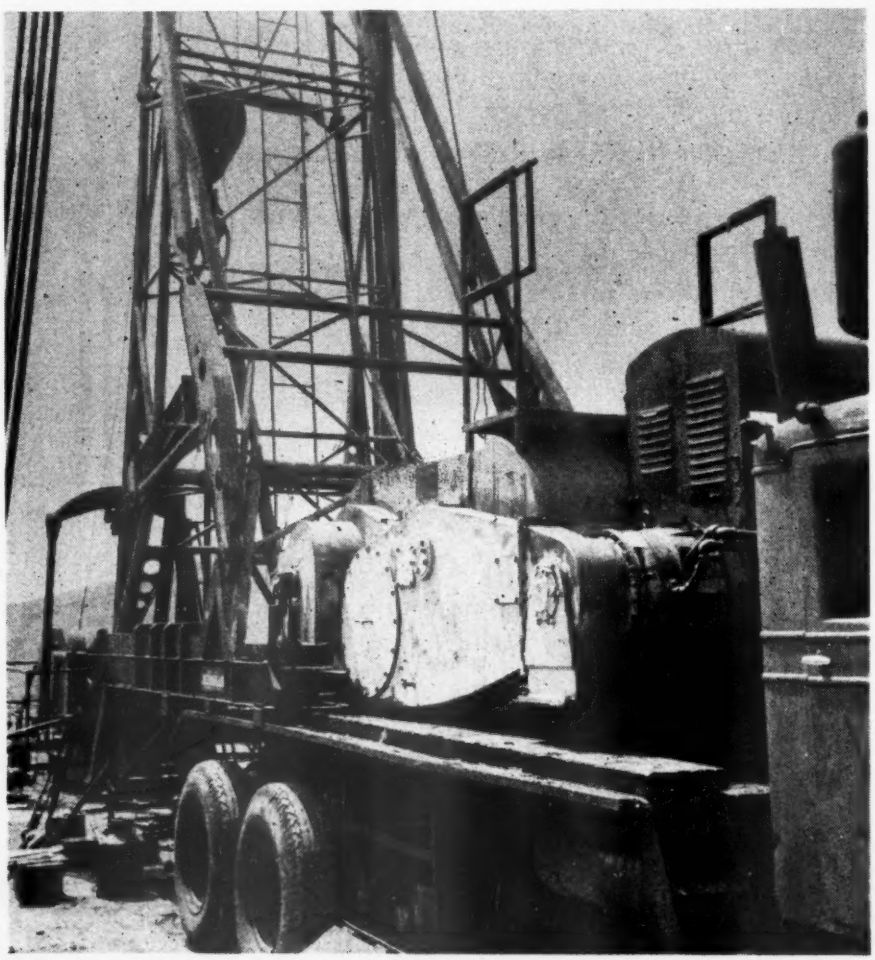
(Continued from Page 68)

mit the full torque of the prime mover and the output shaft normally runs slightly slower than the input shaft. Couplings are intended to operate on installations maintaining relatively constant speed and torque requirements and with the prime mover running against the governor at a constant speed. Loads can be picked up with the coupling but the time lag is greater than with the converter, for this unit does not develop high starting torque. Couplings protect the prime mover from overload at slow operating speeds. They also facilitate the use of push button controls with standard electric motors when starting the motor under full load conditions.

Hydraulic couplings now in commercial production fall into two general classes, the traction or sealed coupling and the scoop tube coupling. In the sealed coupling the fluid remains in the coupling at all times and no provision is made for cooling other than radiation of heat from the surface. The sealed coupling must be run with not more than 6 per cent continuous slip or overheating problems are apt to develop. This coupling is useful on many electric motor and internal-combustion engine drives where the loads and speeds are relatively constant.

The scoop tube coupling has provisions for varying the amount of fluid in the coupling and in this way varying the percentage of slip for any given driving condition. It also has a fluid cooling system to dissipate the heat developed when running under inefficient conditions. This type of unit is useful when one desires to obtain varying speeds and constant torque on the output shaft with a constant speed and constant torque on the prime mover.

● **Selection of hydraulic units.** The selection and adaption of hydraulic units to any piece of equipment requires a thorough knowledge of how that equipment is to operate and what is expected of the hydraulic unit. Each installation requires careful analysis if the hydraulic application is to be successful. Both hydraulic torque converters and hydraulic couplings can transmit power in proportion to the cube of the speed of the input shaft and it is well to work with comparatively high speed input speeds. Internal-combustion engines operating at from 1600 to 2000 r.p.m. are well suited as prime movers. Electric motors designed for 1800 r.p.m. are also particularly suitable. Existing torque converters are capable of transmitting up to 300 hp. and couplings are



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available for much higher horsepower drives.

If the drive has comparatively constant speed and constant torque requirements with infrequent starts, the hydraulic coupling should be considered. If the requirements demand frequent changes in speed and torque and frequent starts the hydraulic torque converter should be considered. Sometimes the economics of the installation dictate the type of unit to be used and other times it would appear that both types of drives have advantages. It is these overlapping requirements that make it difficult to determine which type of hydraulic unit will be of greatest advantage.

● **Geophysical surveying rigs.** Hydraulic couplings are used in geophysical drill rigs and light truck mounted core drilling rigs for driving the mud pump, rotary table, and hoisting equipment. In single engine rigs one coupling will provide the advantages of hydraulics to all drives. In the larger drilling rigs one engine drives the rotary table and powers the hoist when coming out of the hole, whereas a second engine powers the slush pump. In the larger drilling rigs, one coupling is mounted directly on the slush pump engine and the other coupling is mounted on the drive line to the rotary after the take-off has been taken from the truck transmission. Service on this type of drilling rig is fairly uniform and the sealed or traction coupling is adequate for both the pump and rotary drives.

● **Drilling equipment.** Hydraulic drives are found on three general types of oil well drilling machinery. The drawworks engines are often equipped with torque converters; slush pumps have a real need for hydraulic couplings, and torque converters provide a splendid drive for special purpose pumps.

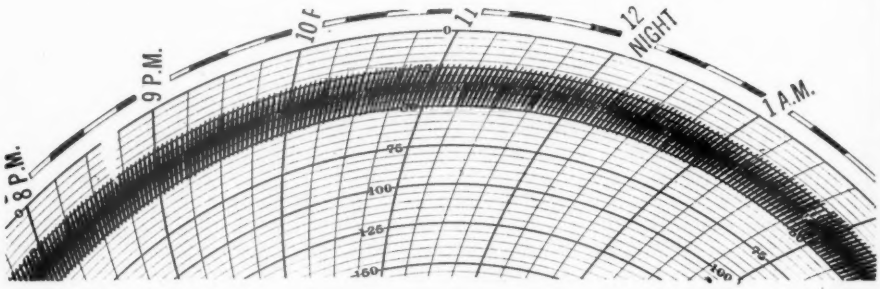
Hoisting operations with the drawworks engines are one of the most typical of all torque converter operations. Each stand of pipe hoisted requires several cycles of power application, each having different torque and speed requirements. These are easily provided by the automatic selection of torque in the converter. In hoisting proper the converter provides the high starting torque required for fast acceleration and also eliminates much of the impact and shock loads on the equipment. The drillers sequence of operations with hoisting engines equipped with torque converter consists of engaging all clutches to provide the proper gear ratio and then opening the engine throttles. The pipe is hoisted rapidly and without shock. In coming out of the hole it is easy to notice the reduction in time required for each succeeding stand as the torque converter output speed increases with each decrease in load. In going into the hole the converter characteristics of high torque at slow speeds make easy coming out of the slips in high gear without "jumping the pipe."

The ability to run the engines at any degree of throttle with a stalled output shaft is very useful in fishing and freeing stuck pipe. The torque converter will keep a continuous strain on the line for any desired period provided adequate cooling is built into the unit. In swabbing, the converter controls all movement of the swab. At open throttle the output shaft will rotate forward and pick up the load, at partial throttle it will stall and hold the load stationary, and at idle will allow the load to descend. In this case the torque converter acts as a hoisting drive, brake to hold or stop the load, and retarder to control the speed of descent of the swab.

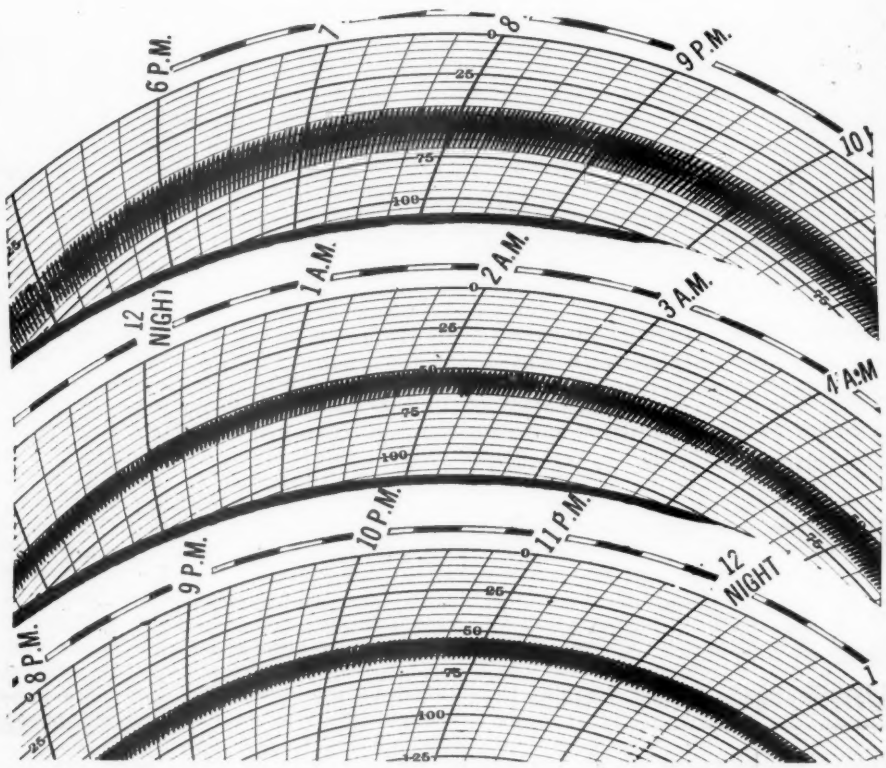
Torque converters are also suitable for rotary table drives. There has been some theoretical objection to this type of application due to their ability to build up torque as the table slows down. This would tend to produce twistoffs of the drill pipe but experience has demonstrated that the drillers do not run into such troubles. Actual twistoffs are often reduced due to the reduction of high shock loads into the drill pipe. The rotary table drive with torque converter equipped engines has proved so successful that one company is producing them in large quantities.

Hydraulic couplings find their place on slush pump drives. Some method of cooling the coupling fluid while the coupling runs at high percentages of slip is desirable in this application and this has resulted in the use of the scoop tube coupling. The use of a cooled coupling permits the drilling crew to maintain constant pressure on the well even when the pump is stalled. The coupling also tends to reduce the fluctuations of pressure resulting from the uneven volume pumped at various positions of the power pump pistons but there is still a large variation in volume. Tests have been made on hydraulically compound-

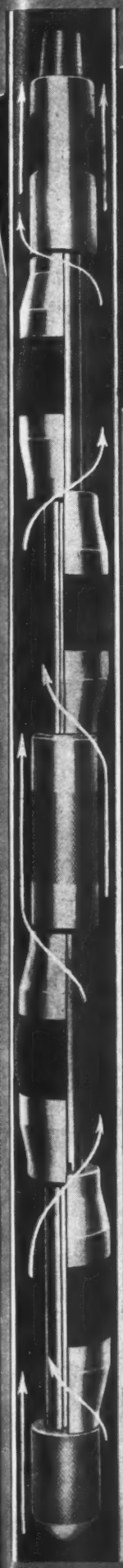
ENGINE INTAKE MANIFOLD VACUUM. Comparison of pumping unit engine vacuum variations before and after hydraulic coupling was installed. Decrease in mean effective pressure is shown on engine for similar pumping conditions.



Friction clutch on engine. 120 to 143-lb. pressure. Left—19.4 strokes per min. Right—22.2 strokes per min.



Hydraulic coupling on engine 22.4 strokes per min. Top—105 to 115-lb. pressure. Middle—132-lb. pressure. Bottom—200-lb. pressure.



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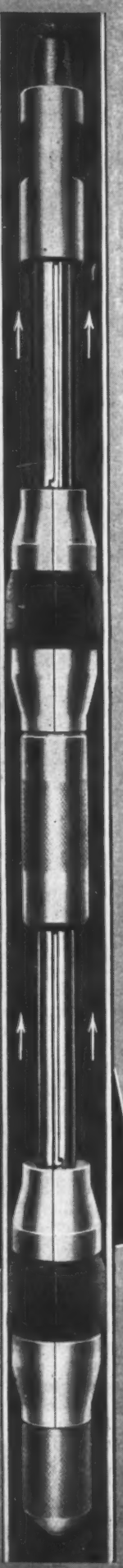

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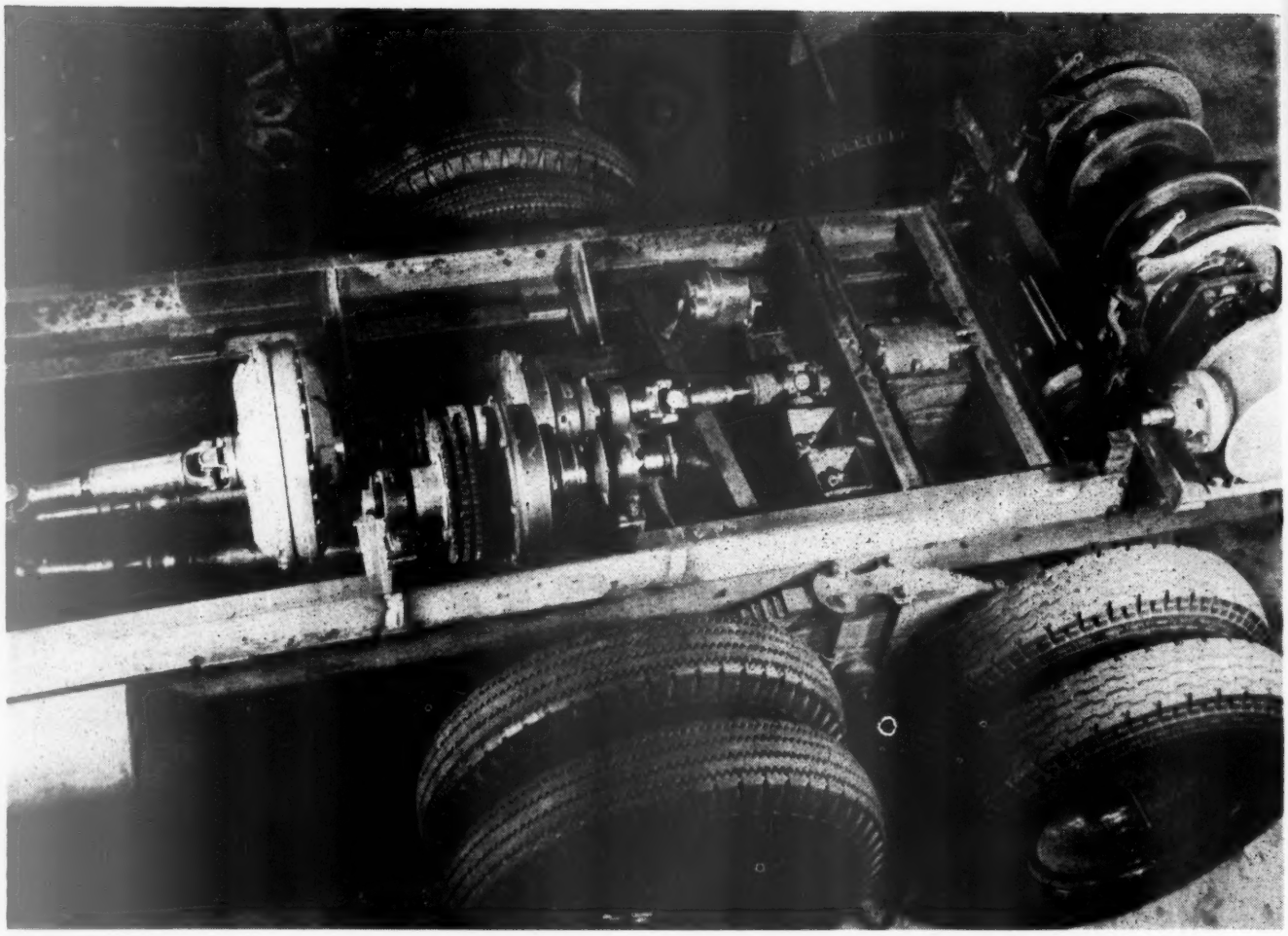

Geophysical surveying rig drives rotary and hoist through hydraulic coupling.

ing conventional duplex pumps when hydraulic couplings and hydraulic torque converters were installed on the engines. The tests did not indicate that it would be practical to drill wells with power pumps hydraulically compounded even when hydraulic drives were installed on the prime movers, although more extensive tests are planned.

Torque converters have also found their place on reciprocating pump drives. When applied to engines driving conventional slush pumps one must provide adequate prime mover power to make up for the loss in the converter. If adequate power is supplied the converter will assure maximum pumping volume and pressure for all conditions of drilling. At surface hole, when maximum cuttings are to be washed from the hole, the circulating pressure is low and the converter output speed and volume pumped are high. As the hole deepens the pressure increases and the pump slows down. The reduction of pump speed is not accompanied by a reduction in engine speed and the engine is therefore not overloaded.

Cementing pumps also present a suitable application for torque converter drives. In this case the cement crew requires large volume at low pressures while pumping the slurry into the well and high pressures at stalled speed while holding the pressure against setting cement.

Sand reels and bailing reels are also driven through torque converters. In these applications the converter can be used as a brake in lowering the swab or surveying instruments into the well. Many swabbing jobs are done with converter equipped rigs without the driller ever touching either his brake or clutch control. The throttle control on the engine determines whether the converter will provide hoisting power to the rig, hold the load stationary or allow the swab to descend at a controlled speed.

● **Production equipment.** Production hoists are equipped with torque converters for the same reason this type of drive is used on heavy duty drawworks for hoisting. Many of these units have but a single drive to the drum and the torque converter characteristics materially aid in going into the hole without changing hoisting ratios.

Special purpose clean out pumps are also equipped with torque converter drives. These pumps are used to reverse circulation in a well, often between packers. Extremely high pressures are often required to break circulation, sometimes exceeding 5000 lb. per sq. in. As soon as circulation is broken the pressure drops and an immediate increase in volume is desired. Converters provide the variety of torque to meet these requirements but the engine and pump must be matched to prevent overloading the power end of the pump at stalled converter speeds.

Shipping pump drives are ideal for hydraulic coupling applications. These run for long periods of time at a constant speed and torque and the coupling protects the entire unit from overloading and reduces maintenance. In case of ob-

Illinois adopts drilling regulations

Regulations for well spacing in Illinois have been legislated for a 20 and 10-acre basis as a part of a Department of Mines and Minerals order that went into effect in mid-October. One well may be drilled to limestone zones for every 20 surface acres and one well to sandstone for every 10 acres. All wells must be drilled at least 330 ft. from property lines and not nearer than 660 ft. to any other well producing from the same zone. Deepening of a well on a tract shall be prohibited until notice is given to offset operators and then the department may have 15 days in which to issue or deny a permit.

Baash-Ross News

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OUR 25th YEAR

Replacing War-Worn Equipment...?

Why not BUILD FOR THE FUTURE *NOW* by converting to Hex Kelly advantages?

MORE AND MORE operators who have war-worn equipment to replace are making the most of their replacement program by converting *now* to Baash-Ross Hexagon Kelly equipment.

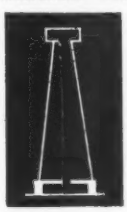
By doing this, they are killing two birds with one stone. Instead of just bringing their rigs back to *pre*-war standards, they are equipping their wells to take full advantage of drilling advancements certain to come in the near future. At the same time—even with present equipment and methods—they are making immediate savings through reduced maintenance, lower operating costs and increased drilling efficiencies by switching to Hexagon Kelly equipment.

Carefully check these Hexagon Kelly advantages. Then consider both the immediate and long-range savings they can mean on *your* drilling operations . . .

Probable "Musts" OF POST-WAR DRILLING

FASTER TABLE SPEEDS

Hex Kellys Run Truer . . . Because hex kellys are *machined* to exceptionally close tolerances from solid alloy steel stock, their dimensions are held to closer limits than is possible with the forged construction of square kellys. This, coupled with the unusually true, concentric bore and the accurate joint alignment, results in a highly uniform weight distribution . . . gives a smoother running, better-balanced kelly at all drilling speeds. This feature has proved to be particularly important for today's high rotational speeds . . . and as drilling speeds increase it will assume even greater significance.



And Are 23% More Resistant to Bending! A straight kelly is absolutely essential to high table speeds, and maintaining straightness has always been a bugaboo of kelly operation. But Hexagon Kellys stay straight longer because they are 23.2%* more resistant to bending than comparable square kellys—*a big advantage!*

GREATER CIRCULATION VOLUME

48% More Circulation Area in Hex Kellys! Even with today's full-hole pipe and high volume pumps, ample circulation through the kelly is important. In post-war drilling, big circulation volumes will probably be still more vital. So why bottle-neck your string with a square kelly when the comparable-sized Hexagon Kelly gives 48%* more circulation area?

INCREASED TORQUES

Hex Kellys Are 28% Stronger in Torque! With tomorrow's greater depths, higher rotational speeds and better pipe steels, torque loads are bound to increase. Both because of its shape and greater cross-section, a Hexagon Kelly will carry over 28%* more torque without failure than the comparable square kelly.

. . . *and this is an* EXTRA *advantage!*

One Kelly for All Operations! This feature is important in *any* drilling program—today's or tomorrow's. With a Hexagon you use the *same* kelly for both regular *and* pressure drilling. This not only saves on equipment costs—for you can standardize *all* jobs to one kelly—but also means far quicker changeover to pressure drilling hook-ups when emergencies threaten . . . a very important advantage. Instead of wasting crucial time breaking out the old kelly and putting up a new one, simply install packing equipment and your hex is ready for any pressure job!

TO MAKE YOUR HEXAGON EQUIPMENT COMPLETE

The Baash-Ross Roller Kelly Bushing!

With this Bushing and a Hexagon Kelly you're ready for the most advanced drilling developments possible. In this bushing the kelly feeds through *rollers*—not high-friction flat surfaces. This insures the maximum in accurate weight control and sensitive bit feed *regardless of table speed or torque loads.* No rig is completely modern without a Baash-Ross Roller Kelly Bushing. Make it part of your Hexagon Kelly program!

Make it a point to get the full story on Baash-Ross Hexagon Kelly equipment *now.* Your nearby Baash-Ross representative will gladly give you the data—or write direct. Pages 255-258 of your Composite Catalog also contain helpful data!

*These figures are based on the widely-used 6" square kelly with 3½" bore vs the 6⅝" hexagon kelly with 4½" bore. Because it is the maximum dimension that governs the selection of a kelly size, the 6⅝" hexagonal (across-corner dimension 7¾") is actually ⅛" smaller in its limiting dimension than the 6" square kelly (across-corner dimension 7⅞"). In other comparable sizes, hex kellys offer proportionate advantages.

structions in the line or closed valves the coupling will slip and prevent damage to the equipment. Many pumps must be started against pressure in the line. With conventional drives it is necessary to bleed fluid until the pump gets up to speed, to prevent overloading the prime mover, and then carefully balance the flow into the system. When couplings are introduced into the drive the prime mover can be started and when it gains speed the valve into the system can be opened. The pump will start when the prime mover gets up to speed and no portion of the system or pump drive will be overloaded.

Pumping unit engine load variations smoothed out by installation of hydraulic coupling on engine.

Hydraulic couplings have been applied to internal-combustion engines driving conventional oil-well pumping units of the walking-beam gear-box type. After the application of the coupling to the engine, tests showed a marked reduction in the variation of engine speed and engine manifold vacuum for each stroke of the pumping unit. The speed variation was less than half that experienced with a conventional friction clutch on the engine and the minimum engine vacuum was greater than the maximum vacuum with the conventional drive. Engine mean effective pressure with the coupling equipped engine was reduced by approximately 20 per cent. The maximum polished rod load was also reduced due to the smoothing out of the power application through the hydraulic coupling.

● **Refinery.** Grease mixers, belt conveyor systems and reciprocating pumps in refineries all benefit when hydraulic couplings are introduced into the drive. Grease mixers are often required to make frequent starts under full load. With a conventional electric motor drive the high starting torque will impose severe overloads on the mixer. Introduction of a hydraulic coupling into the drive eliminates this overload as the coupling does not transmit the high torque at low speeds of the motor. It also reduces the current consumption and prevents overheating the motor.

Hydraulic couplings in belt conveyor system allow them to start under full load without jerking. It is not uncommon to spill much of a packaged load on conveyors by the jerky start of a conventional drive. Couplings smooth this start and also reduce the overload on the starting motor.

● **Transportation.** Application of hydraulic drives to the motor trucks of the oil companies transportation system has been slowed down by the heavy requirements of the military forces. Heavy-duty truck transmissions equipped with hydraulic couplings and torque converters have been on production for some time but they have not been released to the commercial trade yet. Coupling equipped trucks will be a big advantage on long hauls over good roads. Torque converter equipped trucks will provide that smooth power with high tractive effort on the wheels required in moving heavy loads about the fields. Pilot installations of hydraulically equipped motor vehicles on heavy earth moving jobs have proved that truck maintenance costs are reduced to a small fraction of that on standard equipment. Converter equipped city buses have proved the advantages of converter drives for smooth and rapid acceleration.

● **Conclusion.** One must carefully engineer each new application of any hydraulic drive. If this is done and all conditions surrounding the drive are known, one may expect to reduce maintenance and increase production. If this care is not taken it is likely that the drive will become a source of constant trouble. The hydraulic drive is not a cure all for each problem but it has proved that when properly applied it will produce favorable results. All branches of the oil industry have benefited from the application of hydraulic drives and many new satisfactory drives and satisfactory applications will be developed as other operators become familiar with these products.

In the preliminary survey one should remember that the hydraulic coupling is generally best suited for constant speed drives with relatively constant torque. The torque converter is best suited for units having need for a variety of torques and speeds and for drives with the prime mover operating on the throttle.

★ ★ ★

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"The engines have had 900 hours service on this well, it being drilled to 6,635 feet . . . the crew pulled the 6,636 ft. of pipe in one hour and fifteen minutes . . ."

"This pair of engines pulled forty-two Triples in forty-seven minutes . . . also sixty-four hundred feet of 4½" drill pipe in Triples in an hour and forty minutes."

". . . there's not another engine of any make or size to compare with them."

*Names furnished on request.

BUDA

P 615.635.

SOIL CORROSION AND PIPE PROTECTION

T. H. GILBERT, Southern California Gas Company

Introduction

THE purpose of this paper is to present a general discussion on the subject of buried pipe lines, their corrosion in the soil, and the various methods employed to shield them from deterioration. An attempt will be made to outline in a non-technical manner the general procedures and practices at the present time, with as little reference as possible to specific theories or methods. Before proceeding further the writer would like to explain that pipe protection methods are many and varied, so that it would be beyond the scope of this paper to describe them all even if the data were available. Methods mentioned, then, are not to be construed as the best or only ones avail, but rather those that are most typical, most discussed in the literature, or of most local interest as being used in this area.

Soil corrosion

To consider intelligently pipe protection it will be necessary to inquire into the reasons why pipe corrodes. Fundamentally the rusting of iron is the return of this metal into the oxide state in which it is found in nature. The useful life of pipe is dependent upon many factors such as wall thickness, type of soil, type of protective coating, electric current conditions, etc. As regards the actual mechanism of soil corrosion, most investigators agree that it is electrical, caused by electric currents discharging from the pipe and carrying with them iron that subsequently becomes oxidized or rusted. The metal in contact with moist earth passes into solution in the form of ions that carry a positive electric charge. As ions in motion constitute an electric current, we can consider that all corrosion on a buried metallic pipe line is accompanied by an electric current that leaves the pipe and flows into the soil. A variety of different causes may bring about this condition of electrical discharge, such as:

A. Stray electric currents from street railways,
B. Natural differences in soil potential,
C. Galvanic potentials arising from dissimilar metals connected together, and
D. Potentials arising from concentration cells in the soil.

The following is a brief description of each of these factors:

A. Stray currents. Corrosion caused by stray currents from street railways is usually called "electrolysis" or more exactly, "stray current electrolysis." This type of corrosion is characterized by extreme pitting in a concentrated area, and may occur in a relatively non-corrosive soil. When pipe lines are located near direct-current railway tracks, there is a tendency for a current flowing in the rails to pass into the pipes at locations where the resistance of the rail joints is high or when the current density in the rails is high, and to leave these pipes in the vicinity of the generating station or other points of negative potential.

This may be best explained by reference to Fig. 1, which shows the relationship between the street car tracks and the underground pipe system in a typical city. The path of the direct current operating the street cars is shown by the small arrows. The positive terminal of the substation is connected to the trolley wire, and the negative terminal to the tracks or negative feeders, which are connected to the track structure. Under normal circumstances the current travels over the trolley wire to the street car, and back to the substation through the tracks. In this particular example, a 12-in. welded steel main runs from one side of the city to the other, parallel to the street car tracks, with laterals crossing underneath the tracks at several points. Under these circumstances, the steel main and the structures connected to it may be subjected to electrolysis due to the stray ground currents from the street car system.

Assume that there is a high resistance rail joint at A on the street car tracks. There will be a tendency for the current to leave the tracks and pass on to lateral C, passing from there along the 12-in. steel main because the resistance of this path is lower. This current may travel for a distance of a few hundred feet or for many miles along the steel mains until it is again discharged to the tracks in the vicinity of the substation. In Fig. 1, severe electrolysis will occur in the area E on the 12-in. main where the current leaves the main and flows toward the substation, and also in the area F on lateral D where the current flows from the lateral back to the tracks.

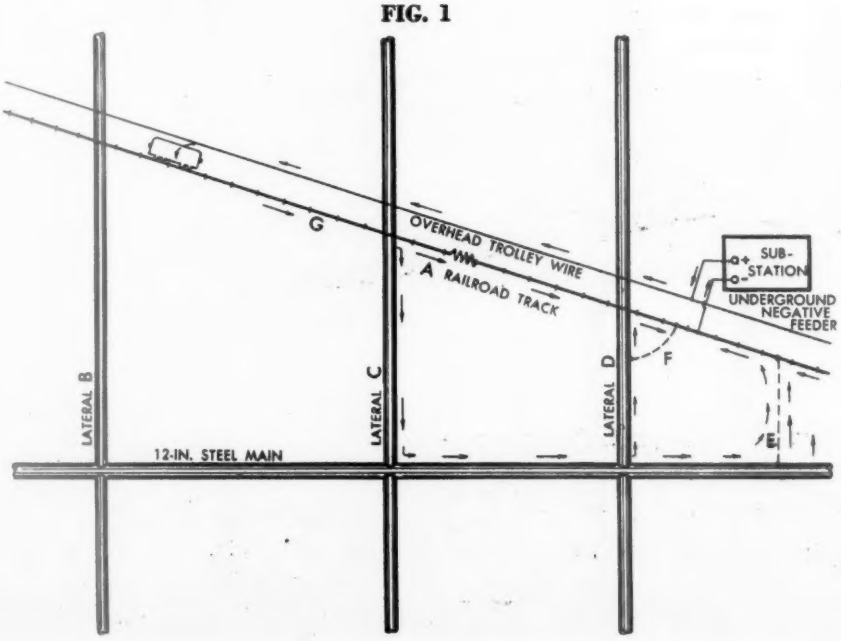
The general method for eliminating or minimizing stray current corrosion is as follows:

1. Reduce the resistance of the track circuit by eliminating high resistance rail joints and by installing additional negative feeders paralleling the track. This work must, of course, be done by the railway company; and or

2. Insulate all pipes very carefully at points where they cross the street car tracks to minimize the pick up and discharge of current. Insulating the pipe may be done by carefully coating the pipe with a good coating and or installing insulating flanges on each side of the crossing. Coating the pipe alone, or installing insulating flanges only, may put the pipe in a hazardous condition, for the pipe will be pitted very rapidly if

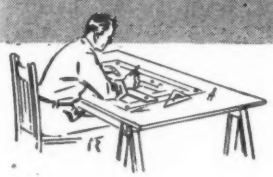
*Presented before California Natural Gasoline Association, September 6, 1945.

FIG. 1



GASO SUCCESS IS BUILT ON THESE PRINCIPLES

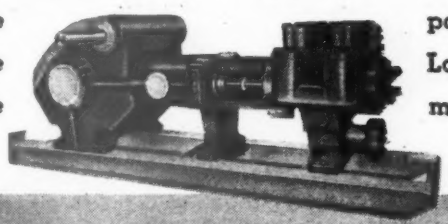
THE MACHINE WITH FEWER PARTS GIVES LONGER SERVICE COSTS LESS TO MAINTAIN AND ACCOMPLISHES EQUAL IF NOT BETTER RESULTS



Simplicity of design is more than a policy at Gaso. It is a religion, practiced ever since the company was founded, more than 30 years ago. . . . Every type and model of pump in the Gaso line has been subjected to the same rigid test by Gaso engineers: Can parts be consolidated, or eliminated, without affecting the operation of the pump?

The results have been most gratifying. Not only has Gaso engineering reduced the number of parts but, in most cases, the parts eliminated have been those which gave most trouble in the past. It is this fact that explains the amazing performance records of Gaso Pumps, their long life, carefree operation and low maintenance cost.

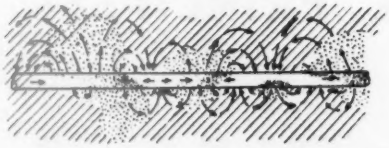
Chosen to power the all-important military pipe lines, Gaso Pumps can be depended upon to give you the complete dependability you look for in your pumping equipment. . . Gaso Pump & Burner Mfg. Co., 902 East First St., Tulsa, Okla. Export Office: 149 Broadway, New York. Shreveport: W. L. Somner Co., 419 Lake St. Los Angeles: Production Equipment Co., 651-653 E. Gage Ave.



GASO PUMPS

for every oil industry need

CORROSION CAUSED BY MIXTURE OF DIFFERENT SOILS

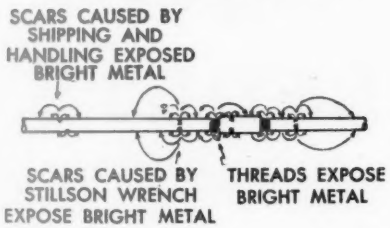


Corrosion due to different types of soil that have been mixed as a result of excavating and backfilling, grading, reclaiming waste land.

CORROSION DUE TO GALVANIC ACTION OF CINDERS AND ACID FROM CINDERS

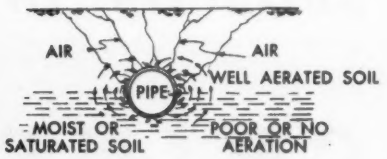
Cinders in the soil may cause severe corrosion in two ways:
(1) Direct contact, setting up active galvanic cells.
(2) Sulfuric acid from cinder above pipe carried down through soil to pipe surface by soil waters.

CORROSION CAUSED BY SCARRING AND THREADING OF IRON PIPE


SCARS CAUSED BY SHIPPING AND HANDLING EXPOSED BRIGHT METAL
SCARS CAUSED BY STILLSON WRENCH EXPOSE BRIGHT METAL
THREADS EXPOSE BRIGHT METAL

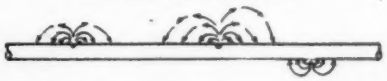
Exposed bright surface is usually anodic to rest of surface—rapid corrosion may result in corrosive soils.
NOTE—A galvanized pipe that has become scarred may not corrode at scars because the zinc galvanizing may protect the metal at the scars.

CORROSION CAUSED BY DIFFERENTIAL AERATION OF SOIL



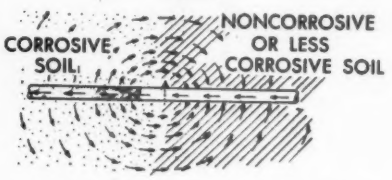
If air dries soil at top of pipe but not at bottom, difference in moisture in soil results in corrosion as indicated above. Dry soil changes metal-to-soil potential making it less negative. This results in greater difference in potential between bottom and top of pipe, which tends to increase current flow and corrosion. Also, air reaching top of pipe tends to destroy polarization which otherwise would tend to reduce current flow and corrosion.

CORROSION DUE TO IMPURITIES IN SURFACE OF PIPE



Corrosion caused by small particles or impurities in surface of pipe—if these are anodic to balance of surface and are small in area concentrated corrosion or pitting results in corrosive soils.

CORROSION CAUSED BY DISSIMILAR SOILS



Corrosion in area of corrosive soil is increased due to pipe extending into less corrosive soil—insulating joint at "A" may materially reduce corrosion.

FIG. 2. Electrolytic corrosion.

the slighest pin hole exists in the coating, or the current may flow from one side of the insulating flange around to the other side through the soil with severe pitting occurring where the current leaves the pipe.

3. Another approach would be to install cables between the pipe and the track in the vicinity of the substation where there is a tendency for the current to be discharged from the pipe and picked up by the track or underground negative feeder, and

4. Install bond cables between pipe lines at locations where current is passed from one line to the other so that the current is transferred through the wire instead of through the soil.

B. Natural differences in soil potential. The ordinary corrosion occurring on iron pipes that are located in isolated areas far from the effect of street railways may arise from the electric currents that flow in the pipe as a result of differences in the potential of the soil. These currents may be very small and may travel only a distance of a fraction of an inch, or they may travel for a distance of several miles. When this is the case they are referred to as "long line currents."

C. Galvanic potentials. Galvanic corrosion, caused by small differences in electric potential between adjacent particles of iron, or between particles of mill scale or other impurity, or between a brass or copper fitting and the iron itself is the result of small electric currents flowing out of the iron into the earth and back again through the dissimilar metal, with corrosion at the point where the current leaves.

D. Concentration cells. A fourth common cause of underground pipe corrosion, concentration cells, it due to the difference in potential in the soil resulting from variations in the concentrations of gases or salts. These potential differences usually are higher than those caused by dissimilar metals. If the concentration of moisture or oxygen in the soil at a certain point differs from the concentration at a point a short distance away, the resulting difference in potential may be nearly a volt. If these two areas in the soil are connected electrically through a steel pipe, the resultant current will cause the pipe to be pitted in the area where the soil has the lower oxygen content. Such concentration cells are usually only a fraction of an inch apart, but because of the nonuniformity of the soil, and the great number of substances that can cause concentration cells, there are thousands of such galvanic couples or batteries formed, each couple tending to make a pit on the pipe. This type of corrosion can also be called chemical, as it occurs locally and without outside influence, but chemistry and electricity resolve into one and the same force in this case. A few example of the last three types of corrosion are shown in Figure 2.

A consideration of all these causes will show that current is discharged into the earth in every case, and it naturally follows that the most corrosion will occur in locations where the earth is most conductive for electric current. This condition is realized, of course, where the earth is wet and contains water soluble salts or chemicals. Therefore, the most corrosive soil is that which is the wettest and contains the greatest amount of saline matter or dissolved chemicals, such as found in salt water marshes or alkali swamps, and we can say that these soils are corrosive, but should remember that they are corrosive in a secondary sense in that they allow or assist the electrical discharge, the current itself being the fundamental cause of corrosion.

Soil testing

There are many obvious advantages to any method or methods whereby the corrosiveness of soil can be forecast with even a moderate degree of accuracy. Perhaps the greatest advantage is that predetermination of corrosiveness enables a pipe line to be protected properly and selectively when it is constructed, rather than to wait for failure to disclose the corrosive locations and then do costly reconditioning work. A great number of different methods have been tried to determine rapidly the corrosiveness of soil, employing both chemical and electrical means. On the whole, and particularly as regards the so-called alkaline soils of the Southwest, the electrical methods are the most successful and have been the most completely developed. They consist, in general, of measurements of the electrical resistivity or conductivity of the soil. This would seem to be a proof of, and a justification for, the electrolytic corrosion theories already discussed, and is the reason why they were discussed at such length. Two common electrical tests are as follows:

● **Shepard soil rods:** These are two steel rods, bakelite covered except at the ends, which ends constitute two electrodes. Two holes, 18 in. or more apart, are driven or augered to pipe depth, and a small amount of water is poured into each hole. The rods are inserted in the moist earth, and the resistivity is measured between them by means of a self-contained battery and resistance meter. Resistivity is considered as inversely proportional to corrosiveness. This method is being used to a consider-

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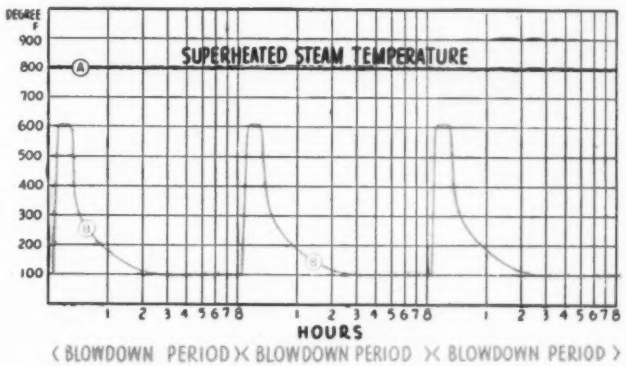
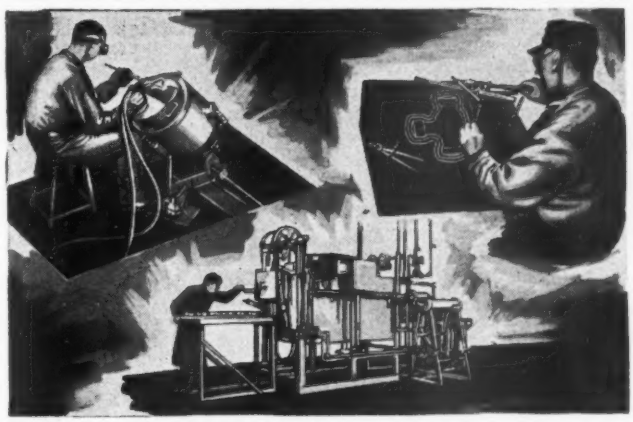
PROBLEM: Two ever-present operating conditions put unusual strain on blow-off valves. They are, (1) abrasive action of grit, scale and sediment blown through the valve, (2) expanding and contracting of valve parts caused by wide and repeated variations in temperature.

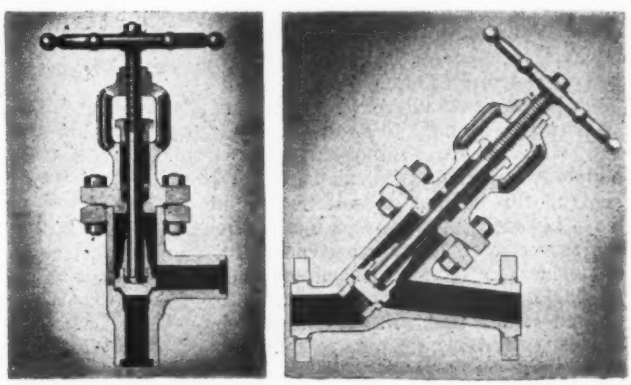
The chart shows temperature variation in a typical blow-off valve installation. Line A indicates temperature constancy of valves operating in steam lines. Line B shows temperature fluctuations in blow-off valve operation from boiler room to saturated steam temperature in a matter of *seconds,* followed by *long periods* of cooling until the next blow-down period.



SOLUTION: Edward attacked the two-fold problem in two ways. First, new techniques were developed for hardfacing seats, disks and other parts which get the greatest wear, and new heat treating equipment was designed for non-scaling heat treatment of parts *after finish machining.* Second, dies and patterns were designed to equalize metal sections so that distortion in heating and cooling was controlled and a valve closed tight under high boiler temperature would still be tight after cooling.



RESULT: Designed specifically for boiler blowdown conditions, today's Edward blow-off valves fit any installation requirement, need almost no maintenance attention. Globe stop type principle is retained for tight seating, less packing wear, and easier repacking. Bulky or irregular metal sections that cause distortion of working parts in frequent heating and cooling are eliminated. Internal parts are few, hence there is less clogging, erosion, adjustment or replacement. These and other design advantages are outlined in detail in the new Edward Blow-Off Valve Catalog, No. 12-D. Write for your copy.



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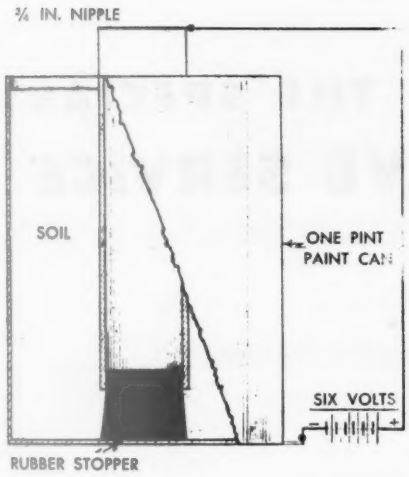


DIAGRAM OF SOIL TESTING APPARATUS

FIG. 3

able extent, and has the advantage of being portable and so can be used in the field, and gives instantaneous results.

● **Nipple and can method:** This method consists essentially of filling a small can with soil, placing a weighed pipe nipple in the soil and insulated from the bottom of the can, impressing a 2 or 6 volt potential across from the pipe to the can, with the pipe positive to the soil and can as shown in Fig. 3, and determining the loss of weight suffered by the nipple after a period of 24 hours. The loss of weight is considered proportional to corrosiveness, and is in reality a measure of the average conductivity of the soil over a 24-hour period. This method has been used for several years by several companies in Southern California.

Such methods as these, although not infallible unless the results are properly interpreted by the dictates of experience, can be made to supply very reliable data on soil corrosiveness. The test results should be supplemented by observations along the pipe line route to take into account sections where excessive moisture or other unusual conditions will be encountered. Such factors as average seasonal and annual rainfall, and maximum and minimum ground temperatures, should be considered. To sum up this section on soil testing, it may be said that a pipe-line route can be evaluated as to corrosiveness with a considerable degree of accuracy, permitting a program of pipe protection to be undertaken that will vary in degree all the way from bare pipe to complete protection.

Pipe protection

Having obtained information regarding the necessity for protection, it should not be difficult to decide what to use. Protective coatings and cathodic protection are not mutually exclusive, but rather complement each other, for in most cases the application of cathodic protection is greatly simplified, and in many instances, made possible by the use of good coatings. The kind of protection will be controlled by the considerations of importance or permanence and desired life, installation economics, ease of coating application, and company policy and operating budget. It would seem entirely possible to give buried pipe complete protection from any corrosion hazard for any desired period by applying a combination of cathodic protection and a good coating consisting of sufficient thickness of any inert, waterproof and electrically resistant material posessing adequate physical strength.

● **Pipe coatings.** Often a material is recommended for pipe protection because it has resisted successfully some type of corrosive attack other than ground exposure. Corrosion underground must be considered as entirely different from atmospheric attack, simple chemical action, or ordinary water immersion. Several other factors enter, such as electrical discharge from the pipe; mechanical movement of the pipe, or soil, or both, producing so-called "soil stress"; rupture of the coating by installation handling or by weight or impact of backfill, or weight of pipe resting on the bottom of the ditch or skids; and physical or chemical absorption of other materials or non-inert substances.

The materials most commonly used are variations of asphalt, coal tar, and petroleum waxes in solid form and applied hot; greases; concrete; and internal or external protectors of woven or paper type wrapper, both plain and impregnated. The impregnating medium is usually a coal tar or asphalt derivative. The paper wrapper may have a cellulose, rag, or asbestos base.

The hot applications have the advantage of almost immediate hardening, thick and rapid coating, and effective field patching, but the disadvantage attendant with heating equipment. Obviously these compounds should be neither soft nor brittle. In general, the coal tars are harder than the asphalts, but more brittle. The coal tars are somewhat less subject to, but not immune from "soil stress." Coal tars are more water resistant and therefore more electrically resistant than asphalts. Finally, coal tars require more heating to liquefy, and harden more rapidly than asphalts, and are consequently more difficult to apply and require more attention to avoid "pin holes" and uncoated portions.

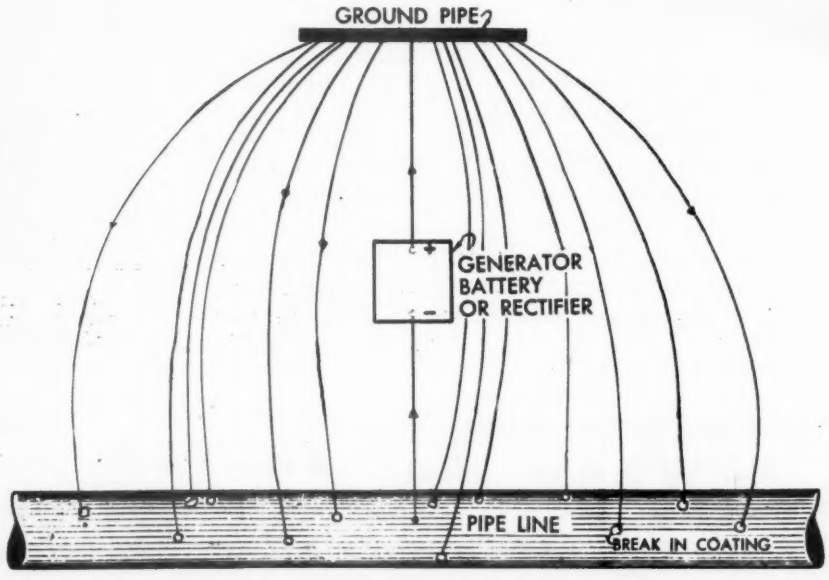
A modification of asphalt is the mastic coating that consists of a mixture of asphalt, sand, or crushed rock, and other materials and is applied hot to a considerable thickness.

By greases are meant materials of heavy grease consistency and non-drying properties. They go directly on the pipe, and it is usually specified that only the very loose rust or corrosion products need be removed, the remainder being absorbed or neutralized. These greases act as a rust preventive at the pipe surface, but must be protected from the soil by a wrapper and external coating. However, because of the lack of solid bond between the pipe and coating, there is danger of the coating slipping or peeling if much installation handling is necessary, especially on large pipe or in warm weather.

For extremely corrosive locations it is essential to apply a coating of considerable physical thickness, and in the presence of continuous moisture to select the material of greatest water resistance. Any thickness can be built up by alternating layers of hot coating and wrapper. "Soil stress" soils require either a re-enforcing wrapper or an external wrapper of non-deteriorating material. Moderately corrosive soils of loose or sandy texture require a lesser degree of protection, such as one coat of hot material and a wrapper, with precautions against handling and backfill injury. Truly non-corrosive soils require no protection other than the film of rust that rapidly forms on the new pipe surface.

No discussion of pipe coatings would be complete without some mention of electrical inspection. The use of holiday detectors has become quite common. These devices of which there are at least

FIG. 4



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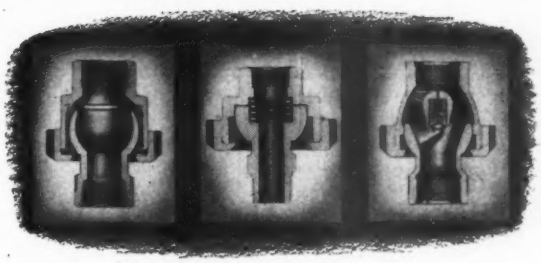

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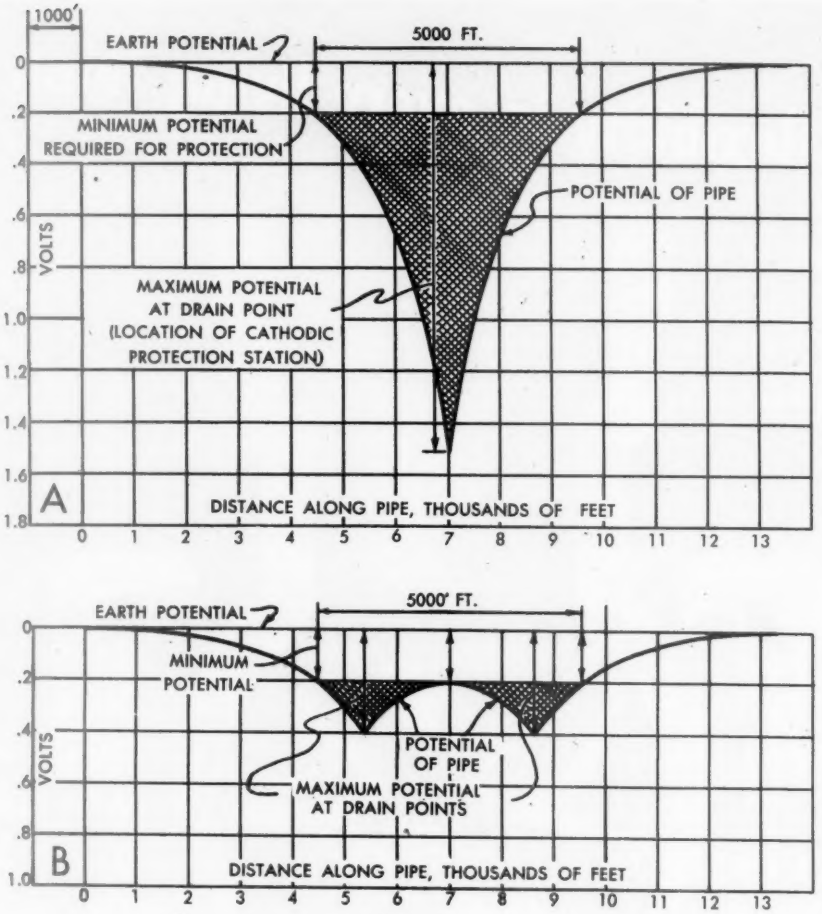

FIG. 5

two types, the "jump-spark" and "electronic," take advantage of the high electrical resistance of the coating in finding holidays or bare spots. The "jump spark" holiday detector makes use of high voltage current, and where a break occurs in the coating, a visible and audible sparking occurs between the steel pipe and the inspection electrode or brush. Every coated pipe line of any importance should be inspected electrically before being lowered into the ditch, and all breaks or holidays repaired. The "electronic" holiday detector makes use of fairly high frequency current, and is used after the pipe line is buried. An electric signal, which is picked up and amplified so that it can be heard with earphones, increases in sound intensity where a break occurs in the coating so that soil and moisture are in contact with the pipe. This method of testing can be used to determine the condition of coatings that have been in the ground for some time or to determine the extent of damage to a new coating as a result of backfilling operations.

● **Cathodic protection.** The action of a cathodic protection station can best be described by comparing it to an electroplating process. The object to be protected or plated, the cathode, is connected to the negative terminal of a source of direct current. The positive terminal of the source of current is connected to a bar of metal that is called the anode. When the anode and cathode are suspended in an electrolyte solution, the anode is gradually dissolved by the action of the electric current that flows from it through the solution to the article being plated. If a spoon is to be silver-plated, for instance, the electric current flows off the silver anode carrying the metal through the solution to the spoon where it is deposited.

A cathodic protection installation is very similar, as shown in Figure 4. The pipe is the cathode; the soil is the electrolyte that carries the current, and the ground electrode is the anode that conducts the current into the electrolyte. As the earth surrounding the pipe lines does not contain the proper iron salts required if iron is to be electroplated, the current passing to the pipe line through the soil from the anode will not actually deposit iron on the outside surface of the pipe. However, the direction of current flow is such that current is prevented from leaving the pipe line, and it therefore will not be subjected to corrosion.

Cathodic protection plus protective coating has two advantages over the use of the latter alone:

1. It prevents the pipe from corroding at points where there are pin holes or defects in the coating.

2. It makes it possible to protect a bare line, or a section of a bare line, or a line having a coating that has deteriorated without having to excavate the main and recondition the coating.

It is almost impossible to provide a perfect and permanent insulating coating on a pipe line with ordinary methods. By the use of expensive materials, elaborate machinery, and considerable care, it is possible to provide the requisite insulating coating that will completely prevent corrosion of the metal beneath. The total cost of the installation usually will be much lower if a good but medium priced coating is applied, using cathodic protection to prevent corrosion of the metal at places where the coating is weak or damaged. The cathodic protection cost in such a case is in the nature of insurance. The second advantage of cathodic protection lies in the fact that it may be applied in place of reconditioning in cases where the existing coating has deteriorated to an extent that something must be done. Many times the pipe line lies under heavy concrete pavement, or under a deep fill, or there are other circumstances so that reconditioning costs are extremely expensive. If the line is not already leaking, the application of cathodic protection will prevent further corrosion and lengthen its useful life.

Cathodic protection implies that the pipe line is to be maintained negative with respect to the surrounding earth. This can be done by using one large anode at least 200 ft. from the line, or by using several small anodes within 25 ft. of the pipe. In the first case it is considered that the pipe has been lowered below the adjacent soil potential; in the second case it is considered that the soil adjacent to the pipe has been raised in potential. In either case, the pipe is cathodically protected by making it negative to earth potential. The first system is generally used when the coating on the pipe is of fairly high resistivity, and the second system is used when the pipe is bare of if the surrounding soil is of extremely low resistivity. Each job has to be separately engineered according to the several variables present. The current required to protect completely a pipe line depends upon the outside diameter of the pipe, the wall thickness, the type and condition of the protective coating, the electrical resistivity of the soil surrounding the pipe line, and the length of line to be protected by the station. No definite current consumption figures can be assumed, but as a very rough generalization, a mile of bare 12-in. line in low resistivity soil may require as high as 150 amp., whereas a mile of well coated pipe in high resistivity soil can be protected electrically with as little as a fraction of an ampere, and two or three miles of coated pipe on which the coating has partially deteriorated may be protected by 50 amp.

When heavy currents are required, it is usually more economical to protect the line with several closely spaced stations instead of attempting to drain a long section with a single station. This is best illustrated by referring to Figure 5. Curve A represents the variation in electrical potential between the pipe and earth along the line protected by a single cathodic protection station. The arrows at the extremities of the curve indicate what are usually considered to be the limits of satisfactory protection. Ex

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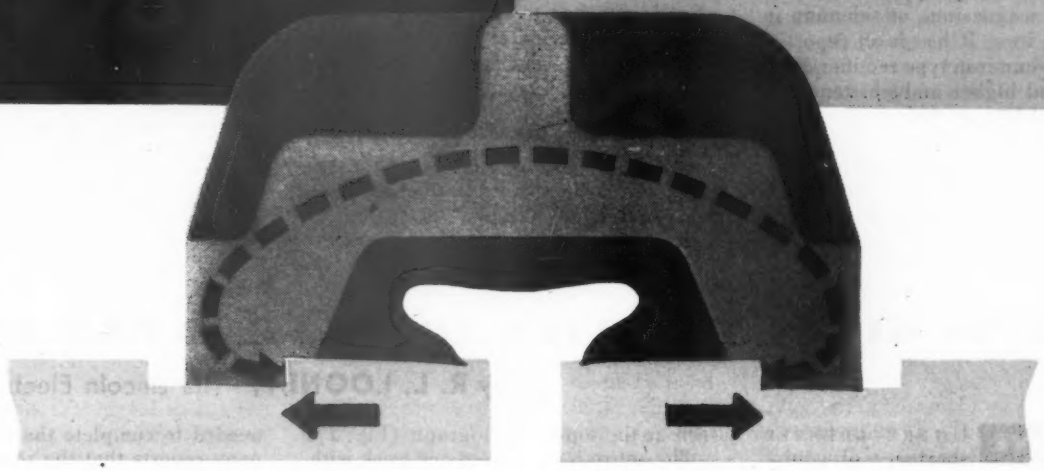

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perience has shown that the pipe should be at least 0.2 volt negative to the soil to receive a minimum of protection. The shaded area in Curve A, then, indicates wasted energy. Most of this waste is caused by the electrical resistance of the pipe metal. In Curve B, the same length of line, 5000 ft., is protected by two drainage stations. With two drainage stations it is unnecessary to maintain such a high maximum voltage at the drain point in order to maintain the same minimum potential at the extremities of the protected area. This results in a saving in power as evidenced by the smaller shaded area.

Any convenient source of direct-current power, such as rectifiers, d-c. generators, batteries, and zinc or magnesium rods, may be used for a cathodic protection station. The most common power source in use today is dry dish type rectifiers that convert the common alternating current to direct current. These rectifier disks are in reality "electric check valves" arranged in a group such that alternating flow is converted to a pulsating flow in one direction. The rectifier disks may consist of copper in contact with copper oxide, copper sulfide in contact with magnesium, or selenium in contact with iron. It has been reported that the selenium-iron type rectifier disks will withstand higher ambient temperatures than other type disks.

When alternating current power is unavailable at the site of the cathodic protection station, and a fairly large current is required, it is necessary to use a direct-current generator as a source of power. The generator may be driven by any convenient rotating power source such as a gas or gasoline engine, a turbine or by a windmill. Wind generators are more common in the middle west where there are steady prevailing winds.

When the current requirement is under 2 amp. and there is no other electric power available, primary batteries of the wet cell type may be used for cathodic protection. This source of energy is practical, however, only when the demand is low because of the extremely high unit cost.

If the current requirement for cathodic protection is low, or if other sources of direct current are not practical, zinc or magnesium rods attached to the pipe line by means of insulated copper wires may be substituted. The zinc or magnesium rod and the iron pipe comprise a galvanic battery in which the zinc or magnesium is the anode, the pipe line is the cathode, and the soil is the electrolyte. As zinc or magnesium rods used in this way constitute a crude battery, the voltage and current available is very low, and it is necessary to use a large number of rods attached to the pipe at frequent intervals. Magnesium, because of its position in the electromotive series, produces a higher potential, or driving voltage, between the anode and the pipe line than zinc. A number of laboratory and field tests on the use of magnesium anodes for cathodically protecting pipe lines and other buried steel structures are now in progress with considerable success reported. The use of magnesium as a means of affording cathodic protection is still in the experimental stage, however, and a sound prediction of the success of its use in various types of soil is not possible at this time. A number of field tests on the use of zinc anodes in this area indicate that a coating of corrosion products forms on the zinc bar, especially in a carbonate soil, which reduces the current output to a considerable extent.

In conclusion, no one believes that the battle against corrosion has been won. Corrosion engineers, operators, and coating manufacturers are constantly striving to improve methods and materials. The failure of almost any pipe line is likely to result in serious property loss, and the pipe line engineer is, therefore, concerned with an engineering problem in which the most economical means for obtaining a desired result is the means that should be used.

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★ ★ ★

P 615.63

WELDING GIVES NEW LIFE TO 27-YEAR OLD ENGINE

By R. L. LOONEY,* The Lincoln Electric Company

EXCLUSIVE UNPRECEDENTED shortages of equipment and material for the past few years have uncovered some remarkable jobs of salvaging important items of machinery that ordinarily would be consigned to the scrap heap.

A recent project that is typical of this type of repair made possible by arc welding consisted of restoring a 1918 pumping engine of 120 hp. that had been in service for many years for one of the major oil companies.

Fig. 1 shows how the holder lugs for holding the cylinder liner in place were restored by welding after they had corroded away. The pads were built up with weld metal specially designed for welding cast-iron to give a good base metal. Finish welding was done with a general purpose electrode of non-ferrous alloy that is readily machinable.

The welded-on pads were 5 in. long, 8 in. wide, and 2½ in. thick. Fig. 2 shows the cylinder head after machining and ready for the installation of the liner.

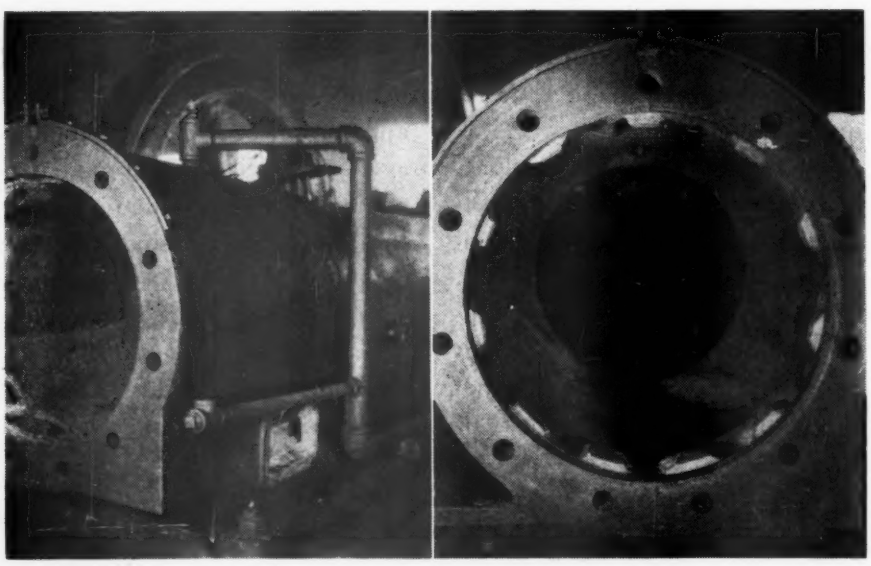
A check crack running entirely through to the top of the casting was also welded good as new with the electric arc process. This fracture before repairing, can be seen at the top of photograph (Fig. 2).

The entire job required one week with one operator working 8 hr. per day. Approximately 250 lb. of weld metal was needed to complete the work. The company reports that the restored engine is now operating very efficiently without leaks, thanks to welded repair. ★ ★ ★

*Mr. Looney is district welding engineer in the Tulsa, Oklahoma, area.

FIG. 1. Cylinder head of old pumping engine restored by the welding process.

FIG. 2. End of head showing new pads for cylinder liner built up by arc welding.



TCC UNIT TURNAROUND PROCEDURE

J. B. GODWIN and **R. B. KENNEDY**
Refining Division, Magnolia Petroleum Company

AN outstanding feature of thermofor catalytic cracking is the relative simplicity of conducting inspection, cleaning and repair when necessary. The major portion of the equipment that requires periodic cleaning is quite similar in design to a conventional pipe still. This factor facilitates rapid completion of the work and minimizes the number of special tools and techniques required to return the unit to useful production. It is significant that most of the turnarounds of the TCC unit in the Beaumont refinery of the Magnolia Petroleum Company, which has been fully described in previous articles[1,2], have been for the purpose of cleaning the feed preparation and distillation systems, and work on the catalytic section has proceeded simultaneously without causing any extension of the off-stream period. The distillation system was on stream 95 per cent of the elapsed time during the past year, with one or both of the reactors in operation for 98 per cent of that time.

EXCLUSIVE

Catalytic cracking is one of the newest processes in general use in the petroleum industry, and whereas much has been published concerning the various means of applying this useful tool in refinery operation, little has appeared to describe the practical aspects of servicing and maintaining the various types of equipment employed. The rapid increase in the number of catalytic units has presented the refinery maintenance staffs with new and unique devices that are quite unlike any refinery equipment in use 6 or 8 years ago. With the above in mind, this article, describing the turnaround procedure applied to the thermofor catalytic cracking unit at Beaumont, has been prepared.

Efficient utilization of time, labor, and materials require extensive preparation before the unit is actually shut down for the turnaround. Material must be accumulated for those repairs and changes to the unit that are foreseeable. A logical sequence of preparing the equipment for the entry of the maintenance crews must be established as well as a sequence for conducting the cleaning and repair work so that all crews may spend their time efficiently and not interefere with the rapid completion of the entire job. To facilitate this planning, turnarounds of all major units are scheduled as far in advance as is practicable. This allows each unit to be worked on separately so that all available crews can be used to restore the equipment to operation promptly.

Inspecting, cleaning, and repairing of a thermofor catalytic cracking unit is relatively a simple matter.

The operating department, the mechanical department, and the engineering department are all directly concerned with unit maintenance, and a brief description of these organizations is necessary to illustrate the turnaround procedure. The refinery is divided into sections, each of which is in charge of a foreman in the operating department. Each foreman has several sub-foremen who supervise operations on all shifts. In the case of the catalytic cracking equipment, a special day foreman is also employed who is responsible for operation and maintenance of that equipment, which includes the TCC unit.

All maintenance is conducted by the mechanical department, which is headed by the master mechanic. Each craft and shop has a foreman who is under the authority of the master mechanic. Daily meetings, attended by all foremen, are held by the master mechanic to distribute and coordinate the work for the following day.

The engineering department supplies a zone engineer who serves as a liaison man to expedite repairs and equipment revisions during turnarounds and as a field estimator to determine the cost of contemplated additions or revisions to existing equipment. The corrosion and inspection section of the engineering department determines corrosion and wear rates on all refinery equipment and works closely with the mechanical department to obtain the information necessary for its records. The complete inspection of all parts of every unit to determine wear and corrosion rates would unduly prolong each turnaround, and, to avoid this, such inspection is conducted by dividing the unit into arbitrary sections. In the course of several turnarounds it is thus possible for the entire unit to be thoroughly inspected and retirement periods for all equipment determined. Equipment in severe service is inspected at more frequent intervals than that operating under milder conditions. Prior to each scheduled turnaround, the corrosion group prepares and distributes a comprehensive report outlining the inspection procedure to be followed. Detailed diagrams of piping, vessels, furnaces, and other equipment are used to show points at which wall thickness must be measured, new corrosion bench marks installed, rates of wear of machinery determined, and additional sentinal holes drilled. Also included in this report is the cleaning procedure to be followed to facilitate inspection, a summary of equipment that has completed its useful life and must be replaced, and a list of necessary repairs submitted by the operating staff. In general, this report attempts to include all foreseeable items of mainteance so that the mechanical department will have an estimate of the amount of work to be done on the unit. After the turnaround has been completed, a second report is prepared. This summarizes the work done during the turnaround, the condition of the equipment, and the corrosion and wear rates determined. In addition, recommendations are included for protecting the equipment against corrosion and wear, if these are necessary.

A COMPLETE record of items requiring attention during the next turnaround is kept in a book maintained solely for that purpose at the TCC unit. The operators are responsible for posting in this book all such items as they become apparent during the run. Shortly before each scheduled turnaround, the day foreman summarizes these entries, prepares a complete list, including any additional work that he deems necessary, and sends this list to the corrosion and inspection department. This list is incorporated in the inspection report, which also outlines measures to be taken during the turnaround for combating excessive corrosion and wear conditions revealed by previous inspections. If changes or additions to the existing equipment are contemplated during the shutdown, a description of these is also included. The report is reviewed by the foremen of the operating department, and, if found complete, it is then forwarded to the mechanical department.

The master mechanic discusses the work to be performed during the turnaround in his meetings with the foremen of the various crafts. A well organized program for the turnaround is developed so that each foreman can assign his crews for rapid and efficient comple-

tion of the job. As the turnaround progresses, the program is revised in the daily meetings, as unforeseen circumstances require. The zone engineer works closely with the maintenance crews, inspecting the work to see that it is completed as specified, and coordinates the work of the various crafts to minimize delays.

Off-stream time of major units is thus held to a minimum by scheduling the turnarounds in advance, preparing a detailed report of the work contemplated, organizing a program of conducting the work, and revising this program to conform to existing conditions as the turnaround progresses. Close cooperation between all departments concerned is essential.

The TCC unit consists of three principal sections: (1) Feed preparation, (2) catalytic cracking, and (3) product recovery and fractionation. The feed preparation system is comprised of pumps, heat exchangers, gas-fired tube-still heaters, a tar separator, and vapor superheaters. Product recovery and fractionation is tied in closely with the feed preparation system for maximum utilization of waste heat from each system. Pumps for circulation of heat exchange streams and delivery of products to storage, condensers, and coolers, in addition to the feed-preheat exchangers, for final removal of heat that is at too low a temperature for economical recovery, a synthetic crude tower, engine-driven compressors, a gas and liquid recontact system, a debutanizer column, and a depropanizer comprise the product recovery and fractionation system. Repair and cleaning of this type of equipment is a standard and familiar procedure to refinery maintenance men and presents no new or unusual problems.

THE catalytic cracking section, although new and unique in design, is simple and accessible for maintenance. Two cylindrical reactors, hot and fresh catalyst storage bins, catalyst elevators, two kilns for regenerating catalyst, and a steam generation system for recovery of heat liberated by regeneration are contained in a steel structure about 235 ft. high. Accessory equipment such as regeneration air blowers, boiler feed water pumps, and an inert gas generation system are housed in a building adjacent to the main structure. A large areaway is provided between the two kilns for convenience in hoisting and lowering tools and replacement and repair materials. Rapid movement of maintenance personnel and small tools is afforded by a passenger elevator, fully equipped with safety devices, that travels to every level of the structure. Practically no temporary scaffolding is required during a turnaround inasmuch as adequate platforms have been provided at all points where work is carried on. The moderate size of the equipment and the convenient location of openings into the reactors, kilns, and elevators facilitate inspection and repair with a minimum of men required to enter the vessels. No unusual tools are needed for kiln and reactor maintenance, inasmuch as the repair work follows conventional boiler, structural steel, welding, and insulation practice.

The internal construction of the reactors and kilns has been found to be quite durable. The reactor is filled to a depth of 32 ft. with angle irons stacked to provide uniform distribution of catalyst and oil vapors. These angles were used for 1½ years before they were inspected. Despite the fact that they were constructed of plain steel, a large percentage were found usable and were reinstalled for continued use. The kilns have been in operation for almost two years with only minor repairs and continue to regenerate the catalyst to a carbon content of less than 0.3 per cent wt., even though reactor charge rates have been increased to more than 125 per cent of design.

Catalyst elevator maintenance is facilitated by the design, which permits removal of parts without complete disassembly. Each bucket of the elevator can be removed individually and separate links can be taken from the chains. It is estimated, after 2 years' service, that the chains will have a life of 3 to 6 years, illustrating that chain repair is not a tough maintenance problem. The sprockets that support and drive the chains can be reversed to present both sides of the teeth to wear. Performance records indicate a life of 2 to 3 years for these sprockets. When maintenance is necessary the chain is supported from the elevator structure by hooks, the links over the sprocket are parted, and the headshaft can then be lifted from its bearings. Extensive field repair is thus made necessary and a faster, better job is obtained by conducting repairs in the shop where machines and tools are all at hand.

It is the operating personnels' responsibility to prepare the equipment for the maintenance crews. The work week for the mechanical department begins at 12:01 a.m. on Monday, and in order that the equipment may be ready at that time the unit is usually shut down about 12:00 noon on Sunday.

SEVERAL hours before the shut down, the feed stock is switched from the normal residuum and heavy gas oil to a clean, light gas oil. This measure flushes out heavy tarry materials from the equipment, leaving only the solid, friable materials to be removed by the cleaning gangs, and reduces considerably the time required for cleaning. The flushing oil is circulated to the normal feed tank and is charged to the unit when operation is resumed. After the equipment has been thoroughly flushed, the feed pumps are stopped and blinds are installed in the suction lines. Immediately after the fires have been drawn from the furnaces, the gas lines to the burners are blinded. Blinding of feed and gas lines is essential if serious danger of fire or explosion is to be avoided.

Oil remaining in the lines and heat exchangers is pumped out, through equipment installed for that service, to the feed tank. Steam is used to displace oil in the furnace tubes into the tar separator. Oil remaining in the tar separator, synthetic crude tower, and strippers is also pumped out to the feed tank. Gasoline in the reflux accumulator, recontact system, debutanizer and depropanizer towers, and feed and reflux drums continues its normal flow until the lowest operable levels are reached. At this point, the remaining liquid is pumped out to a slop tank. At no time are large volumes of oil released into sewers or on the ground in the unit area, or large volumes of gas vented to the atmosphere. If oil is inadvertently spilled, the shift foreman is immediately notified and every precaution is taken to prevent a fire.

After the oil has been pumped out and the towers depressured through the low-pressure gas system, the furnace outlet is opened to the blowdown system and steaming is continued until the tubes are dry and free of oil. The header plugs can then be removed and cleaning begun. Because of the relative ease of preparation, the furnaces are usually the first part of the equipment to be cleaned. Exchanger cleaning can also begin early in the turnaround since they can be opened as soon as the oil has been pumped out.

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FPC postpones Dallas hearing

The Federal Power Commission has postponed to 10 a. m., December 10, the hearing previously set for November 27 in Dallas in the Commission's Natural Gas Investigation (Docket No. G-580). The postponement was made in response to the request of the Railroad Commission of Texas and the Steering Committee of the Governor of Texas, and the new date was selected after consultation with the chairman of the state commission and of the committee. The hearing, as previously announced, will be held in the Baker Hotel.

The New Orleans hearing, third in the regional hearings the Commission is conducting in its natural gas investigation, opened in the Postoffice Building, New Orleans, Louisiana, November 12.

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water before being opened. Water is pumped to the top of each tower through the reflux line, and washing is continued slowly until water appears at the bottom of the tower. Washing then is discontinued until the trays drain, and this procedure is repeated until the trays are free of oil. Gas is displaced by filling the towers full of water. In the case of the synthetic crude tower, the water is allowed to fill the overhead vapor lines and reflux accumulator, displacing the gas and gasoline into the low-pressure gas line. A knock-out drum traps the gasoline, which is pumped out to the slop line. The gas is drawn out through the compressor system and leaves the unit. With the accumulator and tower full of water, blinds are installed in the overhead vapor lines and in the gas line from the accumulator. Vents are opened to allow air to enter and water is drained from the vessels.

As water is draining from the vessels, the maintenance crews begin removal of the manheads, working from top to bottom of the tower. Before the heads are actually removed, the unit operator and a safety man must be present to check for freedom of gas. If the condition is found safe, the manheads are removed as rapidly as the water drains out. This same procedure is followed for each piece of distillation equipment.

PREPARATION of the catalytic system of the TCC unit for maintenance is fairly simple. The first step in the shut down is opening the bypass around the reactors, permitting the superheated, vaporized charge stock to flow directly to the synthetic crude tower. The vapor inlet valves of the reactors are then closed. The outlet valves, however, remain open, so that steam can be used to displace oil vapors from the reactor into the distillation system. Steaming is continued for 30 min. A line from the reactor outlet to the blowdown system is then opened, the valve to the distillation system closed, and steaming is continued until no more oil is released. The volume of steam is gradually reduced, but a positive pressure is always maintained on the reactor until it is opened. In the interests of safety, blinds are installed at the vapor inlet and outlet, and under the safety pressure-release valves, which discharge into the oil blowdown system.

Catalyst circulation is continued at the normal rate of 100 tons per hour with maximum regeneration conditions maintained in the kiln for 3 hours or until the catalyst is regenerated to a carbon content below 0.5 per cent wt. All kiln cooling coils are then put into service, the air preheater is shut down, and catalyst is circulated for about 2 hours to cool it and the rest of the equipment.

Catalyst flow is diverted from the reactor to the hot storage bin. The catalyst drained from the reactor is elevated to the top of the kiln and cooled as it flows downward. It is then elevated again into the storage bin. When the reactor hopper is emptied, the valve in the inlet catalyst line of the reactor is closed to prevent the escape of steam and allow the reactor to remain pressured. After all catalyst is removed from the system water circulation through the kiln cooling coils is stopped. Cool air is blown through the kiln until it becomes cool enough for the maintenance men to enter.

THE stacked angles in the reactor during normal operation become coated with iron sulfide, which reacts spontaneously with the oxygen in air at temperatures above 300°F. This reaction liberates sufficient heat to damage seriously the reactor if it is allowed to start. The reactor, therefore, is allowed to cool for 24 hours under slight steam pressure. Temperatures throughout the reactor are observed closely at all times to be sure that sufficient steam is present to exclude all air. When the reactor is cool, the top manhead is removed and water is sprayed in to wet all the angles. The water flows from the bottom of the reactor, but is not allowed to enter the catalyst elevator housing. Solid-bed reactors, which have no angle-packing, do not require these precautions.

Before operation is resumed, the reactor is thoroughly heated with steam in order to evaporate the water before catalyst is allowed to enter.

The operating personnel cooperate fully with the maintenance crews so that thorough repair and cleaning is obtained in a minimum length of time. Their many duties during a turnaround keep them fully employed. The head operator

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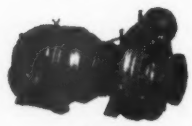
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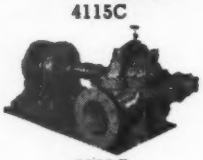
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of the unit is responsible for having all equipment ready for work whenever the mechanics reach it. He must see that blinds are installed according to safety regulations and that no oil or gas remains in the equipment when it is opened. The operators are well acquainted with the unit and can be of much assistance to the mechanical force, who are only around the unit when it is being repaired. Their knowledge of the location of electrical switches and utility connections for air, water, and power saves time in the layout of maintenance equipment. The operators can describe the nature of unsatisfactory operation and thereby aid in determining the source of trouble quickly. Location of items mentioned in the work list can also consume much of the mechanics time if operators are not available to point these out.

Several safety men are on duty at all times during the turnaround. These men see that the safety rules and regulations are observed, and test for the presence of unsafe atmospheres or combustible gases before men are allowed to enter vessels or before burning and welding is permitted in any area. For example, if welding is to be done in a tower, the safety man, with the assistance of an operator, determines that all necessary blinds have been installed, that the tower is free of oil, and that no combustible gases are present. He then fills in a form to this effect, which both he and the operator sign. This form must be in possession of the man doing the work before any work is performed in that vessel. These stringent measures are necessary to keep accidents at a minimum.

The frequent installation of blinds is vital to the prevention of serious fires and serves to confine the danger and damage if a fire is inadvertently started. Valves are never trusted to keep oil or gas out of the unit during a turnaround. Blinds are also employed to prevent steam or water being turned into vessels in which men are working.

As the turnaround progresses, the operators inspect the work of cleaning and repair and see that it is completed to their satisfaction. They also cooperate with the corrosion and inspection department. The operators work with the mechanics assigned to drill and caliper the equipment, pointing out the locations marked and described in the corrosion and inspection report. As the measurements are taken, the operators record the information on forms provided for that purpose. When this work is completed the operators are responsible for having all test holes closed and welded.

Testing of the equipment after reassembly is completed again requires cooperation between mechanical and operating groups. When a vessel is closed, the operators fill it with water or steam, apply the correct testing pressure, and inspect thoroughly for leaks. If leaks are found, operators prepare the equipment for the work necessary and test again after the work is finished. Oil and gas are not used for such testing because of the fire-hazard involved. Equipment such as pumps, blowers, instruments, and the like, are also inspected by the operators to determine their operability before returning the unit to service.

A list of instructions is provided to the operators of the TCC unit outlining the general method of shutting the unit down, preparing the equipment for maintenance, and resuming operation. These instructions are fundamentally a summary of important items that must not be neglected, and are not intended to comprise a detailed operating procedure.

Thermofor catalytic cracking presents almost no unusually difficult maintenance problems. This factor coupled with diligent planning and close cooperation between refinery divisions allows rapid completion of turnarounds and avoids long periods without production from the unit.

Acknowledgment

The writers wish to express their appreciation to J. W. Newton, W. W. Leach, and P. L. Smith for permission to publish this article, and acknowledge the assistance of those who contributed to its preparation.

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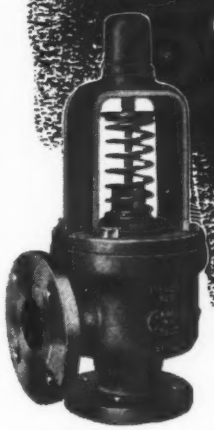

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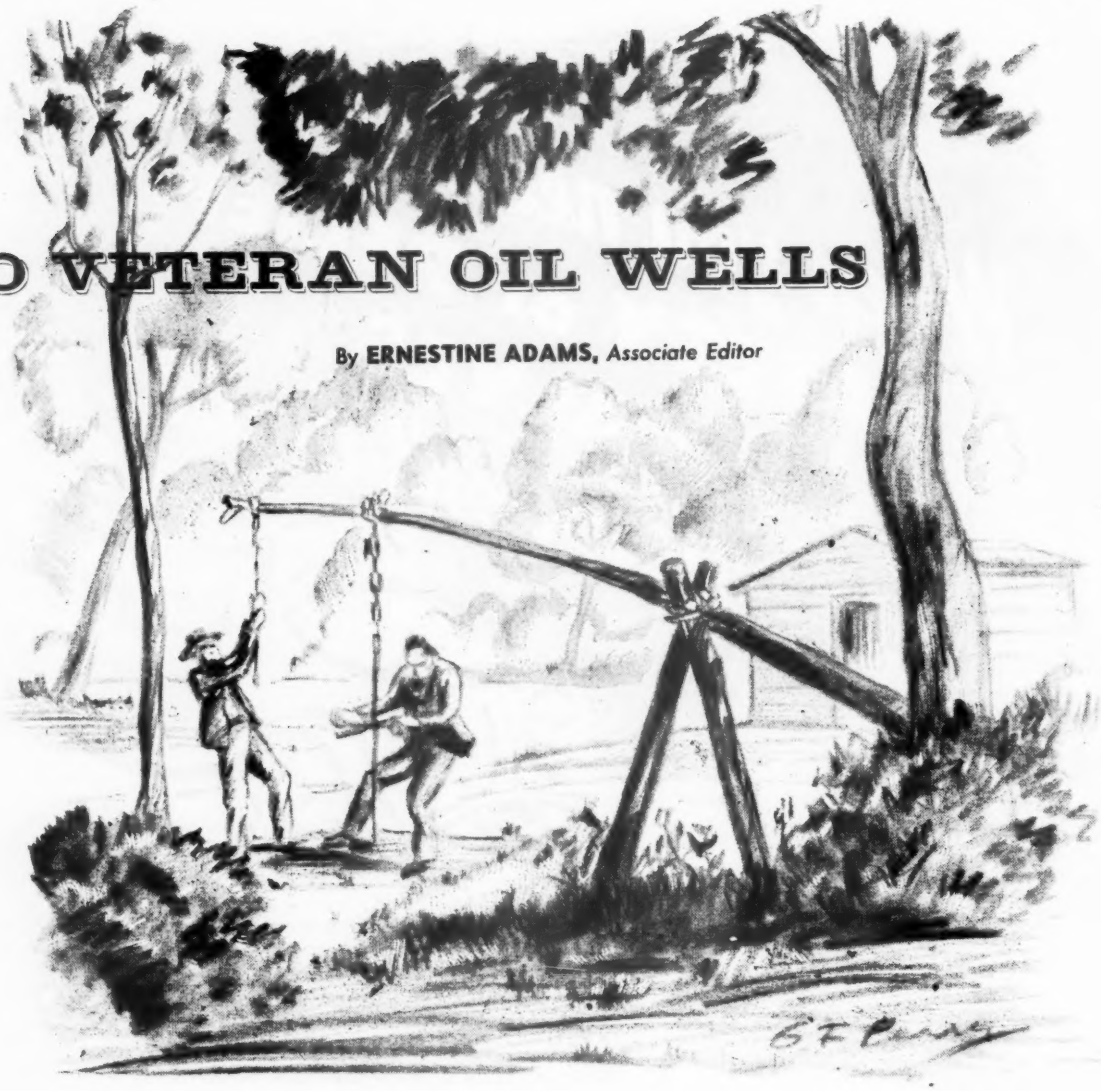

TWO VETERAN OIL WELLS

By **ERNESTINE ADAMS**, *Associate Editor*

A SEARCH for the oldest producing oil well has uncovered some interesting sidelights of the beginnings of the oil industry and found, still in comparative obscurity, two oil wells whose history almost spans that of the United States oil industry.

EXCLUSIVE

Right to the title of "Oldest Producer in the World" is asserted for each of the two veteran wells. This record is not easily checked in the U. S. and is even more difficult to verify for the world. Several months of inquiry have uncovered no other well with as strong basis for its claim. The closing of the old timers, however, must come before the record for "longest period of production" can be determined for either well.

One of the producers was drilled not far from the Drake well on Oil Creek, in Pennsylvania, August, 1861. It was then known as the Colby well and has since been renamed the McClintock No. 1.

In the valley of the Ohio River are two producers that are almost as old as the U. S. oil industry.

The other octogenarian is not 200 miles away in southeastern Ohio. It is the Old Buell No. 1[1] at the edge of Macksburg near Duck Creek. The well takes its name from the first owner, Barnum Buell, who with George Dunlevy completed it in 1862 or 1863. The obscurity of the date is not surprising considering the length of time required for drilling in those days. The Drake was started in 1858 and completed in August, 1859.

Because the Civil War from 1861-65 curtailed oil development, there were few wells drilled in this period.

One of the owners of the McClintock, J. E. Robinson, searched records and compiled what information he could find about the old well. It was drilled on the H. McClintock farm at the Borough of McClintockville between Rouseville and Oil City. It came in only four months after the first flowing well, the famous Rouse No. 1, which was approximately ¼ mile north of the Colby. The Rouse caught fire and 16 persons were burned, including the owner, Henry Rouse, who died from his injuries. The Rouse was completed in April, 1861.

One of the first owners of the McClintock was State Senator William McMullen, who had a fourth interest. The well was doubtless drilled with a steam engine, similar to the Drake rig, that being the method in common use in that vicinity.

Originally a good producer, it was said to make 50 barrels of oil a day from its two producing sands. The Venango County third sand at 481 to 516½ feet,

[1]James H. Warburton, Pattin Brothers Division of Acme Fishing Tool Company, brought our attention to the Old Buell. He was looking for Pattin engines that had given extremely long service and B. M. Eagler, one of the Buell lease owners, had a Pattin pumping engine on one well that had been bought 42 years before. Warburton took out a photographer and got a lead on the Old Buell at the same time. Mrs. Augusta K. Bedilion of *The Marietta Daily Times* has also supplied invaluable information.

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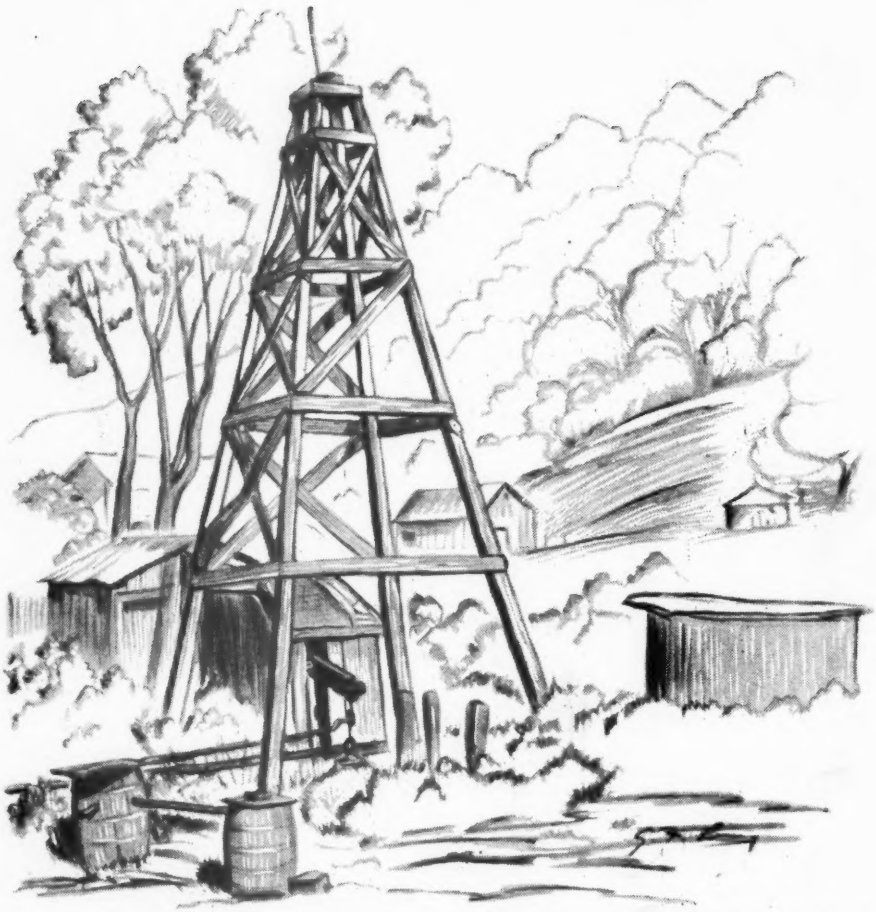
was the most substantial; the second sand at 340 feet to 367 feet was considered only fair.

Neither the date drilling began on the Old Buell nor when it was completed is a matter of record. Buell owned the 120-acre farm that lay part in Washington County and part in Noble. He drilled the Buell in the corner of Noble.

THE well was "kicked down" by the slow and cumbersome spring pole method, the same kind of churn drilling the Chinese used 2000 years ago. One end of a long green pole was sunk in the ground and weighted with stones or was lashed to a stout tree. The pole was laid over a crotch in a post or, as in the case of the Buell, was supported by a small derrick. To the small end were attached a chain and a long heavy piece of iron. The primitive bit was pointed enough to make some progress in drilling each time the tools hit the bottom of the hole. Sometimes the force was supplied by pulling the small end of the sapling down and then allowing it to spring back. Or a platform was attached to the drilling end of the spring pole and the up-and-down motion was made by one or two men standing on the platform shuffling their weight from one leg to another, teeter-totter fashion[2].



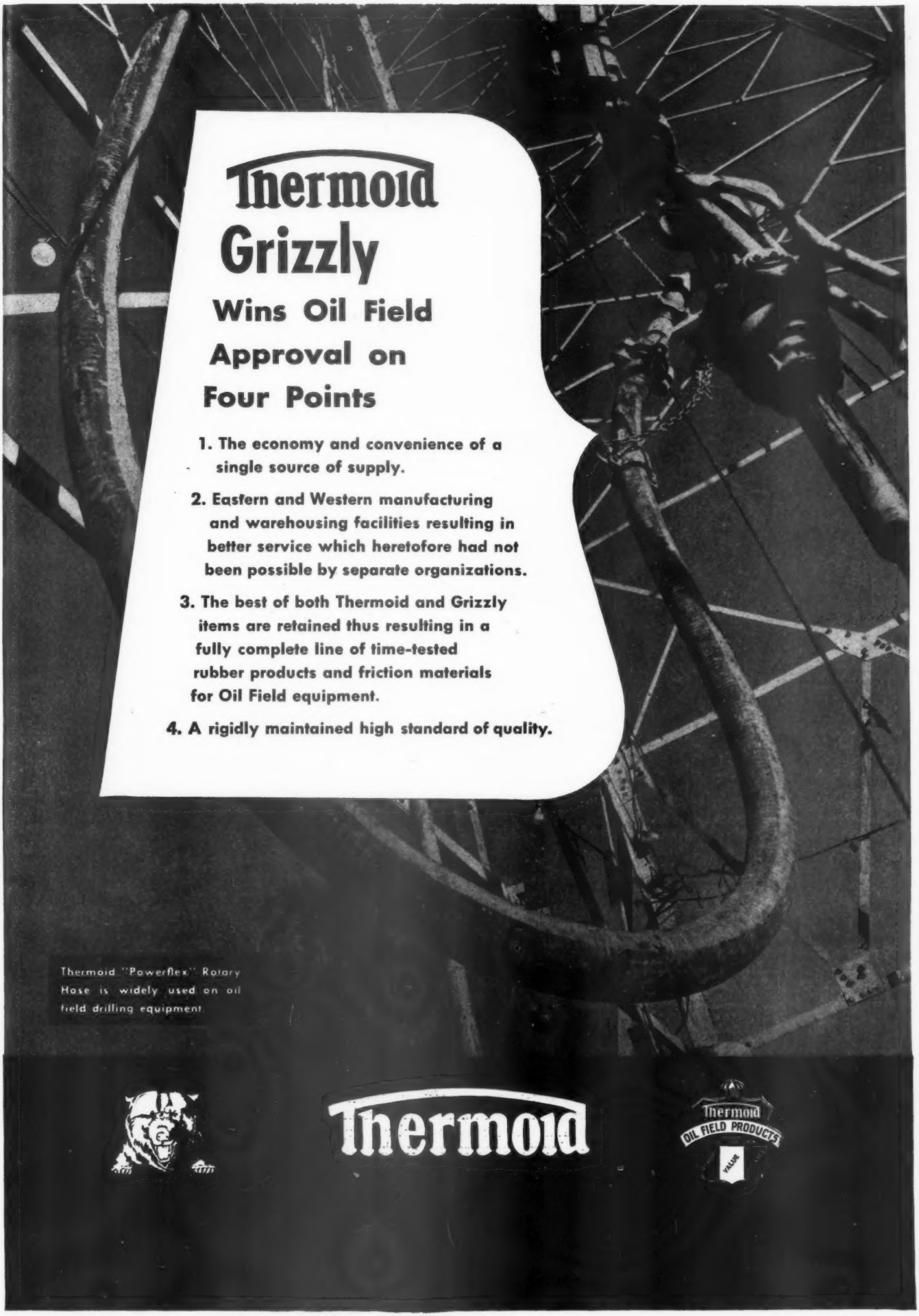
In Southeast Ohio is
The Old Buell No. 1

In Pennsylvania is
The McClintock No. 1

This ancient drilling method served very well for shallow wells of less than 200 feet but the Buell reached a depth of 508 feet, discovering the Macksburg 500 sand at 474 feet. The time required is difficult to estimate. Wells along Duck Creek were drilled to 475 ft. or more, however, as early as 1814. The area was famous for its salt wells. It was certainly drilled during the Civil War because one of the drillers worked on location during furlough periods from the army.

George Rice of Marietta, a pioneer independent oil operator who was known as an avowed enemy of The Standard Oil "combine," bought the lease and Buell No. 1 in the late '60's. In 1871 he compiled a record of the well by interviewing all those who had any contact with its drilling. This record passed to the Speary Brothers when they purchased the property from Rice's daughter, Mrs. Ida Butts, in 1912. C. Fred Speary interviewed old settlers again at the time and found they did not agree on the date that oil was found. R. C. Smithson, who was a leading merchant in Macksburg and a Civil War veteran, said the well was producing when he came home from the war in 1863. It

[2] *Oil Well Drilling Methods*, Victor Ziegler, 1923.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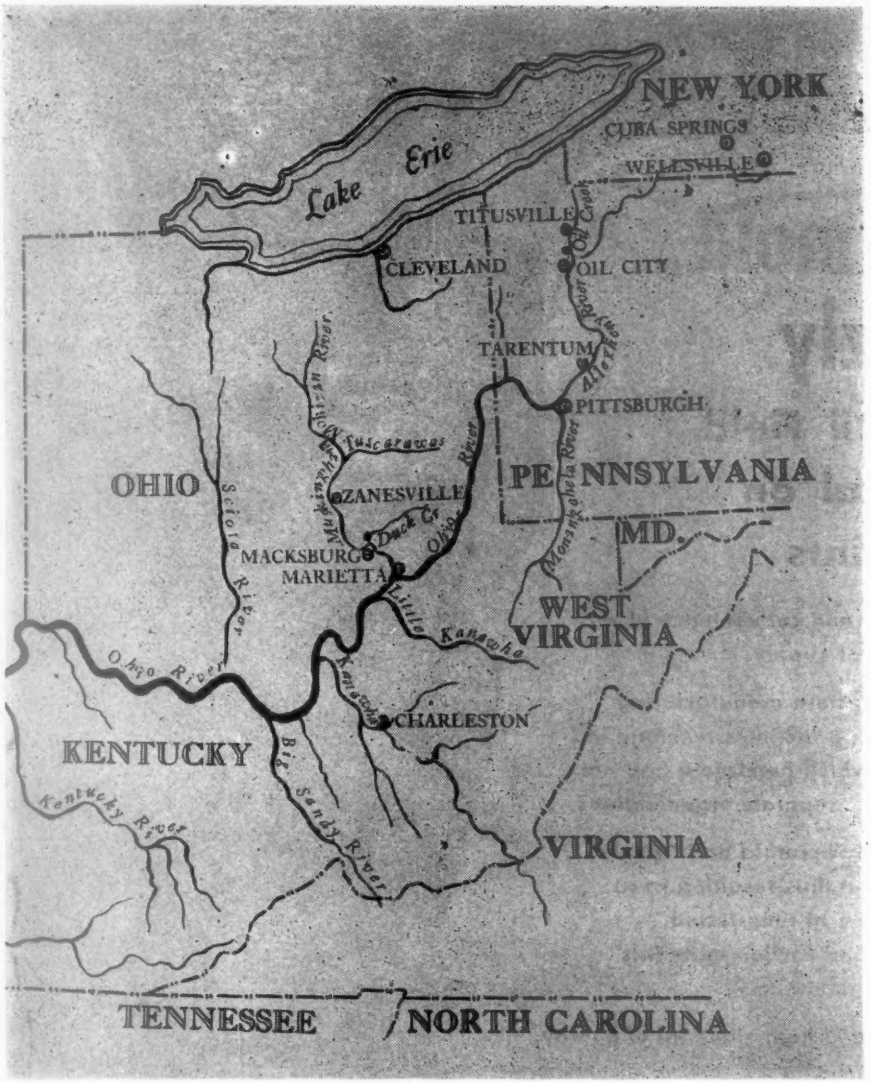

Valley of the Ohio River was the birthplace of the oil industry in the United States. North of Oil City on Oil Creek is the McClintock, drilled in 1861 and still producing. Near Macksburg and Duck Creek, Ohio, is the Old Buell, drilled in 1862 or 1863 and producing to this day. Titusville, in northwest Pennsylvania, is the scene of the famous Drake well.

was being drilled in 1862 and may have been completed then. Mrs. Augusta K. Bedilion, local historian at Marietta, has a record of the Speary findings and the notes left by Rice. Few early wells have a history so well documented despite the vagueness surrounding the exact date of its drilling.

PRESENT owner of the McClintock is the Brundred Oil Corporation of Oil City, Pennsylvania, which acquired the property in 1927, according to W. J. Brundred, president. Production of the well had declined to about 2 barrels per month at the time and the company repressured the wells on the lease with air. The McClintock is now producing approximately 18 inches per week, in a tank 4 feet in diameter, which is equal to about ½ barrel a day of 43.8 deg. gravity oil. Materials in the well have been renewed a number of times to keep it in good shape.

In the old days oil from the well went to a small refinery at the edge of Oil Creek owned by the late Henry H. Rodgers, one-time vice president of Standard of New Jersey.

Buell No. 1 was sold by the Spearys in 1930 to B. M. Eagler and Walter Fischer, who do a pumping job daily for the well with a 2-hp. engine on the derrick floor. The pump is an anachronism inside the fragile wooden derrick that is similar to the one used for the drilling of the well. The oil is pumped into a container—an ordinary gasoline drum. When the drum is full it is trucked to a tank that feeds the Buckeye Pipe Line Company carriers. At the time Rice owned the well he had a pipe line from his field to the river. Boats were filled and towed to Marietta and the oil pumped into the refinery that Rice built there.

Original production of the Buell was 15 barrels a day. The last 30 years has seen little change, the output going from ⅓ to ¼ barrel a day. Other wells drilled close to the Buell seemed to have no affect on its production.

Rice was the first one to run iron casing into the Buell. The original casing was wooden. He also gave the producing sand numerous shots with "rock powder" during the last years of the nineteenth century, according to his record. On October 26, 1900, a nitroglycerine shot was tried. The Old Buell was "shot with 166 quarts of nitro glycerine and had a magnificent explosion. Blew top of derrick off. There was a reaction."

It took a major repair job on a damaged derrick and collapsed casing but the work was completed and the Buell pumped on.

BOTH wells are good evidence that their producing sands have staying qualities. The Venango County Third sand in Pennsylvania varies considerably in area and in its characteristics. It is almost the same depth as the Macksburg 500, which is 30 ft. thick in the Buell. The Buell opened up this rich sand in the southeastern Ohio area.

Both the McClintock and the Buell have a background of the early "burning springs" tradition. Oil was common on the small tributaries of the Ohio River. Salt makers who drilled along Oil Creek and Duck Creek banks as well as on other streams found oil a not uncommon but most unwelcome occurrence. In the Lewis Evans[3] map of 1755 the word "Petroleum" is printed along the Ohio valley.

In February, 1826, Dr. S. P. Hildreth of Marietta wrote in the American Journal of science: "Petroleum affords considerable profit and is beginning to be in demand for lamps and work shops and manufacturies. It affords a clear, brisk light when burnt this way and will be a valuable article for lighting the street lamps in the future cities of Ohio."[4] So it is reasonable to believe that not all salt wells that unfortunately made oil were abandoned even before the Drake was drilled for oil in 1859 as a commercial project.

The McClintock and the Buell are in locations that saw the awakening of the oil industry. They also represent a continuity in the progress of production that reaches from the spring pole to automatic pumps. They have had owners that recorded their history, expended more on them than could ordinarily be expected in profit, and gave them the advances made by the industry; they got new steel casings, nitro shots, air pressure — whatever advantages the times afforded.

Both old wells are tough. For over 8 decades they have kept pumping, repaying care and interest with unequalled persistence. There are many wells that produce more oil in a day than the veterans have in a lifetime but they nevertheless command the respect of an industry that is also tough and persistent.

★ ★ ★

[3] "The Birth of the Oil Industry," Paul H. Giddens, 1938.

[4] *American Journal of Science*, February, 1926.

SMALL SCALE CATALYTIC CRACKING

By **H. D. NOLL**, *Houdry Process Corp.*

and

V. O. BOWLES, *The Lummus Co.*

Refiners representing 42 per cent of the nation's crude capacity possess no catalytic cracking facilities whatsoever. A high percentage of this group are refiners processing less than 10,000 bbl. per day of crude.

A new integrally designed small TCC unit has now been developed to enable refiners in this class to meet competitive octane requirements. This article presents process and economic studies on the applications of the TCC process to the small refinery, and demonstrates its profit possibilities.

THE petroleum refining industry is approaching an era that is in many respects unique in its history. Normally the adoption of new processes and new refinery technique must be justified strictly from the standpoint of economics and with consideration of the quality of products dictated by competitive marketing con-

(Continued on Page 110)

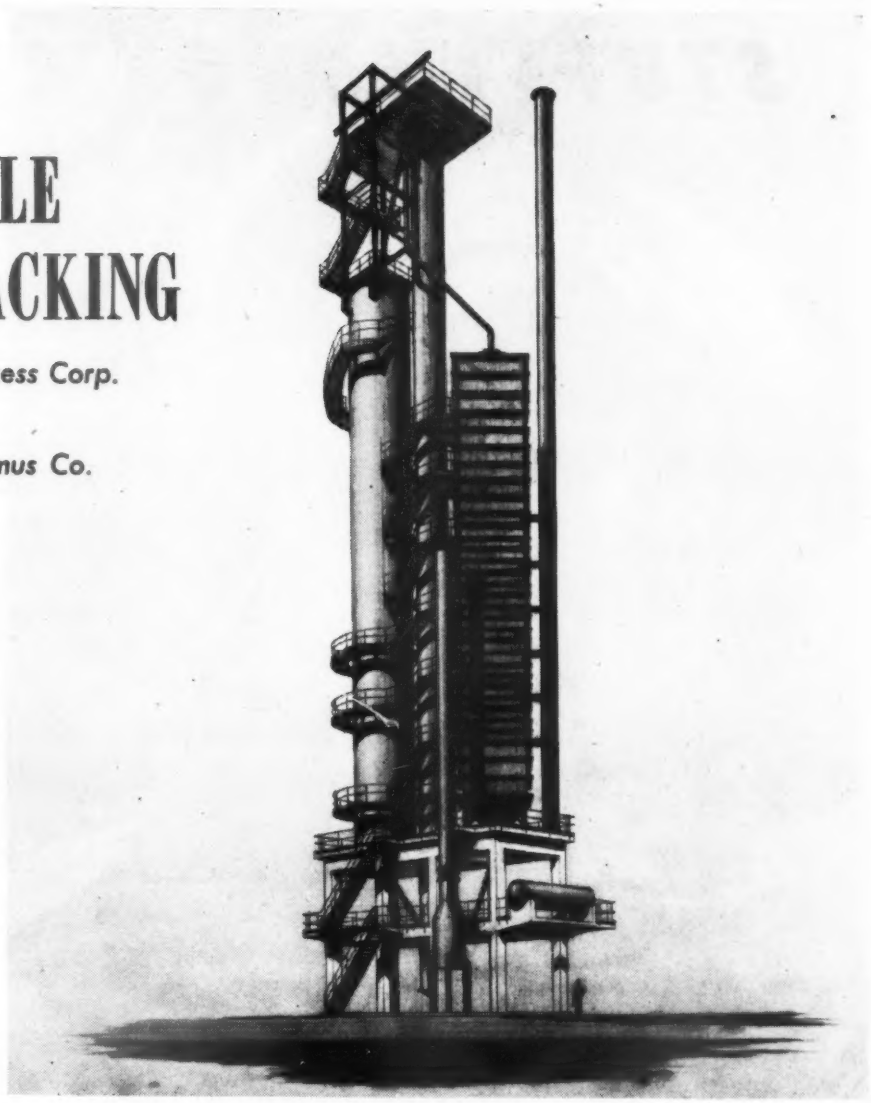

FIG. 1.

TABLE 1

Summary of yearly earnings, retirement period and earnings end of 10 years after investment retirement

Case No.	1	2(C)	3	4	9	10
Octane no.	76	76	76	76		
Type of process (1C)	D, Th, VB	D, VB, TCC, Th.	D, VB, RTCC, Th.	D, VB, RTCC		
Investment	$ 1,400,000	$ 2,755,000	$ 2,905,000	$ 2,510,000		
Earnings per year	1,239,000	1,547,000	1,641,000	1,632,000		
Payout, years	1.13	1.78	1.77	1.54		
Earnings, end 10 years	10,990,000	12,715,000	13,505,000	13,810,000		
cc's TEL per gal.	2.10	0.85	0.75	0.75		
Octane No.	78	78	78	78		
Type of process (1B)	D, LR, Th, VB	D, VB, TCC, Th.	D, VB, RTCC, Th.	D, VB, RTCC		
Investment	$ 1,550,000	$ 2,755,000	$ 2,905,000	$ 2,510,000		
Earnings per year	1,164,000	1,475,000	1,567,000	1,564,000		
Payout, years	1.33	1.87	1.85	1.60		
Earnings, end 10 years	10,090,000	11,995,000	12,765,000	13,130,000		
cc's TEL per gal.	1.60	1.30	1.20	1.20		
Octane no.	80	80	80	80	80	80
Type of process (1A)	D, HR, Th, VB	D, VB, TCC, Th.	D, VB, RTCC, Th.	D, VB, RTCC	D, A, HR, Th.	D, A, TCC, Th.
Investment	$ 1,640,000	$ 2,755,000	$ 2,905,000	$ 2,510,000	$ 1,745,000	$ 2,945,000
Earnings per year	1,015,000	1,380,000	1,469,000	1,480,000	993,000	1,424,000
Payout, years	1.62	2.00	1.98	1.70	1.76	2.07
Earnings, end 10 years	8,510,000	11,045,000	11,785,000	12,290,000	8,185,000	11,295,000
cc's TEL per gal.	2.00	1.90	1.80	1.75	2.00	2.00
Octane no.	82	82	82	82	82	82
Type of process* (1A)	D, HR, Th, VB	D, VB, TCC, Th.	D, VB, RTCC, Th.	D, VB, RTCC	D, A, HR, Th.	D, A, TCC, Th.
Investment	$ 1,640,000	$ 2,755,000	$ 2,905,000	$ 2,510,000	$ 1,745,000	$ 2,945,000
Earnings per year	898,000	1,246,000	1,338,000	1,365,000	857,000	1,282,000
Payout, years	1.83	2.21	2.17	1.84	2.04	2.30
Earnings, end 10 years	7,340,000	9,705,000	10,475,000	11,140,000	6,825,000	9,875,000
cc's TEL per gal.	2.90	2.75	2.60	2.50	3.05	2.90

Code: D—Diesel fuel to sales. HR—Reforming 1600 BPCD. LR—Reforming 1050 BPCD. TCC—Once through TCC cracking. RTCC—1:1 recycle TCC cracking. Th—Thermal cracking virgin or TCC gas oils. VB—Visbreaking tar separator bottoms or other reduced crude. A—Asphalt to sales. (1A), (1B), (1C) refer to subcase under Case 1.

STUFFINGBOX TROUBLES

*Valuable man hours, formerly spent in re-packing pumps and lost down-time, can now be put to productive use.

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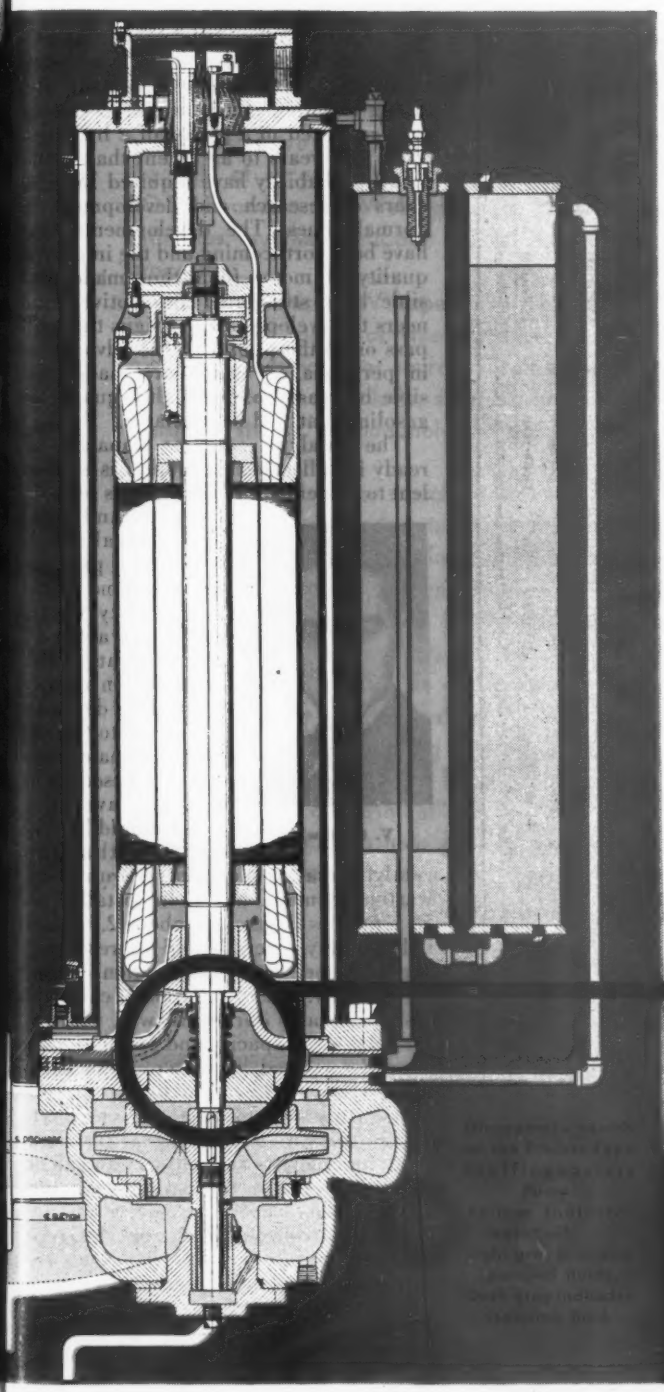
HOT • COLD • CORROSIVE • VOLATILE LIQUIDS PUMPED CONTINUOUSLY • SAFELY • WITHOUT LEAKAGE • • WITH BYRON JACKSON STUFFINGBOXLESS PUMPS



Basically different, this pump does away with the necessity for the conventional stuffingbox, frequent repacking and lost down-time by the substitution of a simple mechanical seal, operating under a low fixed pressure differential. Built integrally with the motor—using any one of several standard type Byron Jackson Pumps—the Stuffingboxless Pump is explosion proof. Pumped fluids cannot be either contaminated or lost in their handling.

Since there is no escape to atmosphere of pumped liquid, the Stuffingboxless Pump is ideally suited for the pumping of butane, propane, pentane or other volatile fluids. Where the product being pumped is of high value, savings from leakage have quickly amortized pump installation costs. Capacities, heads and temperatures available with the Stuffingboxless Pump cover an extremely wide range. By proper selection of pump type a large variety of individual requirements can be met. Any Byron Jackson engineer will be glad to furnish complete details on the application of this new and improved method of pumping.

The outstanding feature of the Stuffingboxless Pump is the employment of a low fixed pressure differential at this point—the seal—which remains constant at any given capacity or head, regardless of change in suction pressure.

BYRON JACKSON CO.

Houston • LOS ANGELES • New York

TABLE 2—Summary of economics.
(Diesel fuel to sales)

Case No.		1A		1B		1C		2A		2B		2C		3		4	
Revenue	Cents per gal.	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day
10-lb. R.V.P. motor gasoline	6.250*	4,740	12,443	4,843	12,713	4,975	13,059	5,346	14,033	5,491	14,414	5,722	15,020	5,941	15,595	5,516	14,480
Kerosine	4.250	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678
Diesel fuel	3.625	1,100	1,675	1,100	1,675	1,100	1,675	1,100	1,675	1,100	1,675	1,100	1,675	1,100	1,675	1,100	1,675
No. 2 fuel	3.625	...	...	...	...	...	...	...	...	...	...	...	...	...	...	638	1,002
Residual fuel	2.145	2,067	1,860	2,045	1,841	2,003	1,803	1,391	1,252	1,369	1,232	1,327	1,194	1,078	970	949	854
Dry gas (FOE)	2.145	698	628	636	572	522	470	685	617	623	561	509	458	478	430	329	296
Excess butane	1.450	20	12	...	...	...	...	132	81	74	45	...	...	70	43	74	45
Total revenue			19,296		19,479		19,685		20,336		20,605		21,025		21,391		21,030
Operating costs																	
Crude	3.33	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000
Crude distillation		10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420
TCC cracking		...	...	...	...	...	...	3,650	540	3,650	540	3,650	540	7,310†	710	7,310†	710
TCC gas plant									212		212		212		223		223
Thermal cracking‡		6,100	751	5,540	706	4,500	585	4,782	586	4,222	539	3,182	378	2,467	314	1,500	107
Debutanization[e]			18		16		11		34		31		26		34		30
Catalytic polymerization		180	157	153	147	106	130	310	204	287	196	239	179	259	186	229	175
Gasoline inhibitor		4,740	5	4,843	5	4,975	5	5,346	5	5,491	5	5,722	6	5,941	6	5,516	6
Taxes, interest, insurance			225		212		192		410		397		377		398		344
TCC royalty								3,650	183	3,650	183	3,650	183	3,655	183	3,655	183
Thermal royalty		6,100	183	5,540	166	4,500	135	3,282	98	2,722	82	1,682	50	987	30	...	...
Catalytic polymerization royalty		180	38	153	32	106	22	310	65	287	60	239	50	259	54	229	46
TEL to 76 CFRM (M ce's)		149	269	223	402	439	790	29	53	69	125	204	367	187	337	174	313
Total operating costs			16,066		16,106		16,290		16,810		16,790		16,786		16,895		16,559
Earnings, dollars per day			3,230		3,373		3,395		3,526		3,815		4,237		4,496		4,471
TEL to 78 CFRM (M ce's)		239	430	325	586	606	1,091	79	141	150	270	312	562	299	539	278	500
Earnings, dollars per day			3,069		3,189		3,094		3,438		3,670		4,042		4,294		4,294
TEL to 80 CFRM (M ce's)		398	717	488	879	794	1,429	164	295	265	477	457	823	449	808	405	730
Earnings, dollars per day			2,782		2,896		2,756		3,284		3,463		3,781		4,025		4,054
TEL to 82 CFRM (M ce's)		577	1,039	712	1,281	1,107	1,993	292	525	415	747	661	1,190	649	1,168	598	1,043
Earnings, dollars per day			2,460		2,494		2,192		3,054		3,193		3,414		3,665		3,741
Investments (process equipment only)																	
Crude distillation			$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000
TCC catalytic section			...		...		...		650,000		650,000		650,000		725,000		725,000
TCC fractionation section			...		...		...		475,000		475,000		475,000		575,000		575,000
TCC gas plant									470,000		470,000		470,000		520,000		520,000
Thermal cracking and gas plant		1,080,000		1,010,000		890,000		760,000		685,000		565,000		480,000		100,000	
Catalytic polymerization		210,000		190,000		160,000		285,000		270,000		245,000		255,000		240,000	
Total		$1,640,000		$1,550,000		$1,400,000		$2,990,000		$2,900,000		$2,755,000		$2,905,000		$2,510,000	

*Based on 75 per cent housebrand+25 per cent premium fuel. †Total feed—1:1 recycle. ‡Total for thermal cracking and gas plant. [e]Utilities only.

(Continued from Page 107)

ditions. The war years, however, witnessed the installation of more than 1,000,000 bbl. daily of potential catalytic cracking capacity under conditions where the consideration of economics was secondary to the primary purpose, which was rapid installation of plants for aviation gasoline production with the minimum expenditure of critical materials. Extensive search and development over many years was intensified during the war, prompted by the necessity for producing the maximum of aviation gasoline. This resulted in a greatly accelerated rate for commercial scale adoption of catalytic cracking developments. Refining technique in catalytic processing was advanced in a period of a little less than four years to an extent that would in all probability have required 15 to 20 years of research and development in normal times. The developments that have been forthcoming and the improved quality of motor fuels thus made possible have stimulated automotive engineers to develop engine designs that will pass on to the public all the advantages in performance, which are made possible by reason of the higher quality of gasoline that will be available.

H. D. Noll

The catalytic cracking capacity already installed in this country is equivalent to 23 per cent of the nation's refinery capacity and, generally speaking, is capable of producing a volume of super quality motor fuel equivalent to 26 per cent of the nation's normal peace-time demand for all motor fuels. These estimate, however, are based upon national averages and it should be recognized that the catalytic cracking capacity required by wartime demand has been installed in 52 refineries processing about 2,700,000 bbl. per day of crude and representing almost 60 per cent of the nation's refining capacity. The installation of catalytic cracking plants during the war, with respect both to capacity and location, was often determined by factors other than those that would normally apply for peace-time considerations. Thus, although the national average of installed catalytic cracking capacity is equivalent to 23 per cent of the nation's refining capacity, this catalytic capacity has actually been installed in 52 refineries, representing 58 per cent of the nation's refining capacity. This group of refiners has slightly more than 40 per cent of catalytic cracking capacity, based upon crude runs, whereas refiners represent-

V. O. Bowles

(Continued on Page 114)

BABCOCK & WILCOX is a logical place for refineries and chemical plants to turn for sound, practical answers to all tubing problems—for a number of good reasons.

First, because so many *do* bring their tube questions here—and have for 35 years—B&W can answer yours in the light of exceptionally broad experience in supplying BOTH Seamless *and* Welded tubing for every purpose in refineries, synthetic rubber plants and other chemical processes.

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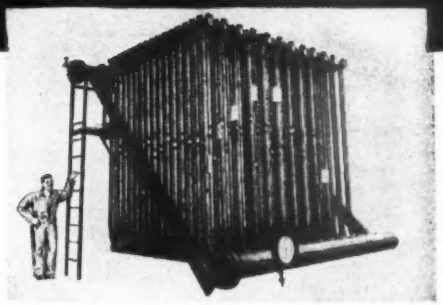
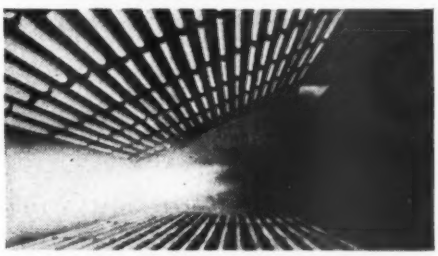
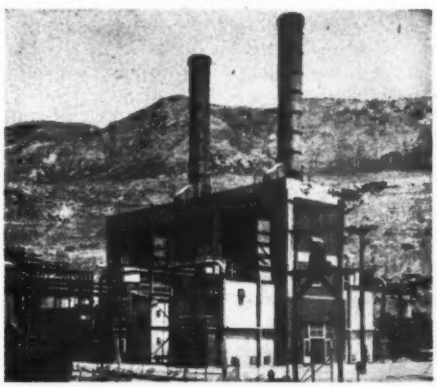
Make the expertly staffed B&W laboratory your "question and answer department" on any tube problems. Call on this service *now* to help get war-weary equipment in shape for peacetime competition.



This catalyst case for a dehydrogenation unit includes B&W Stainless Steel Tubes.



B&W Croloy Tubes have proved their time- and cost-saving advantages in high temperature services.



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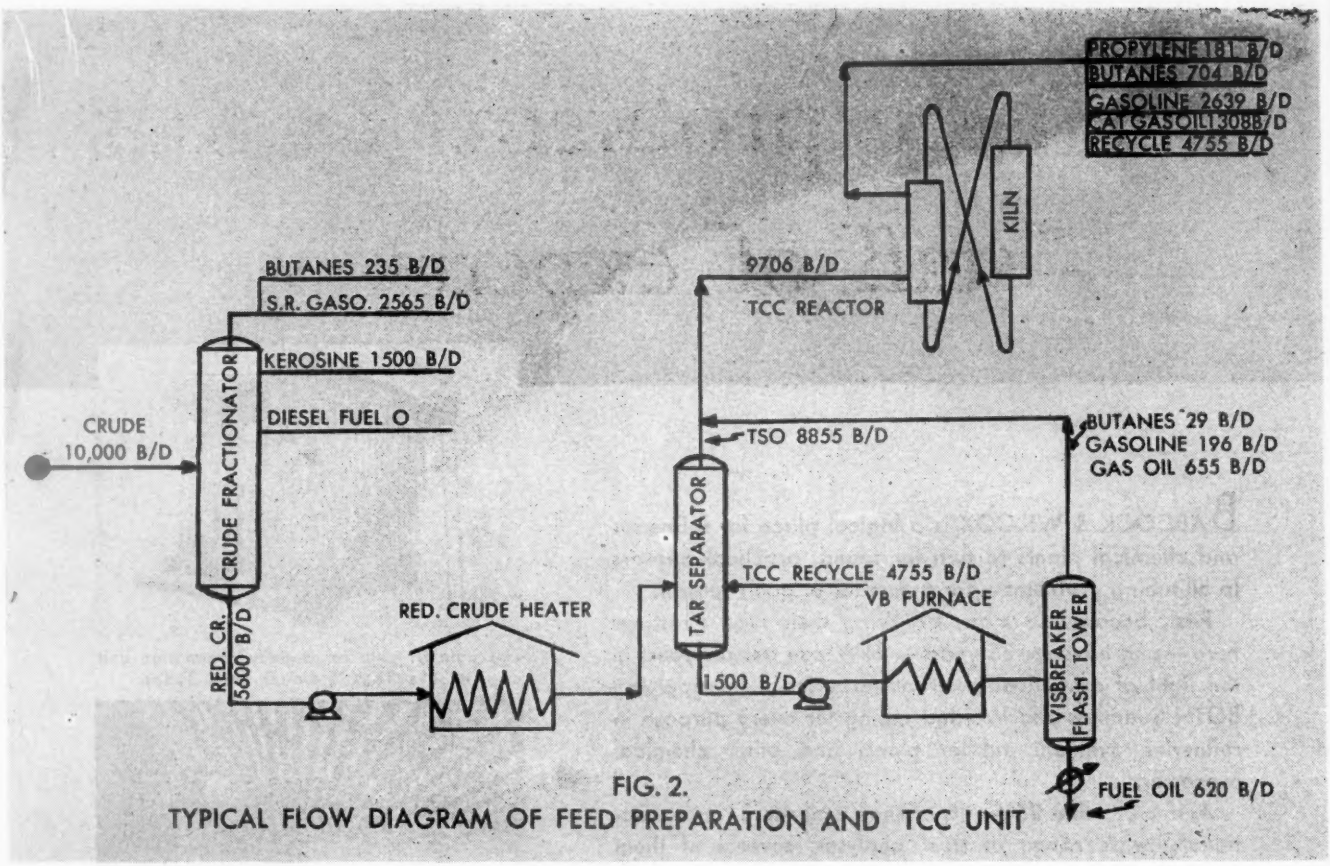

FIG. 2.
TYPICAL FLOW DIAGRAM OF FEED PREPARATION AND TCC UNIT

(Continued from Page 110)

ing 42 per cent of the nation's crude capacity possess no catalytic cracking whatsoever. In the face of this situation, the outlook for the potential postwar markets indicates a motor gasoline situation that may well be more competitive than at any time in the history of the industry. Thus, those refiners equipped with adequate catalytic capacity will be able to take advantage of the improved quality motor fuel they are in a position to manufacture in order to expand further the sales of motor fuel in their marketing areas. Those who have not installed catalytic cracking facilities will be hard-put to meet competitive quality and maintain motor gasoline markets.

The problem of motor fuel quality is even more vital to the operators of small refineries who in years past have depended largely upon the gasoline market to insure continued profits. It is necessary to their sound economic position and to the strength of the petroleum industry as a whole that the operators of small refineries be able to meet the challenge of competitors by producing motor fuel of at least equal quality and at a cost that will enable them to maintain a satisfactory margin of profit. Houdry engineers for some time have been at work on the development of a

FIG. 3
EARNINGS PER YEARS
VS. OCTANE NUMBER

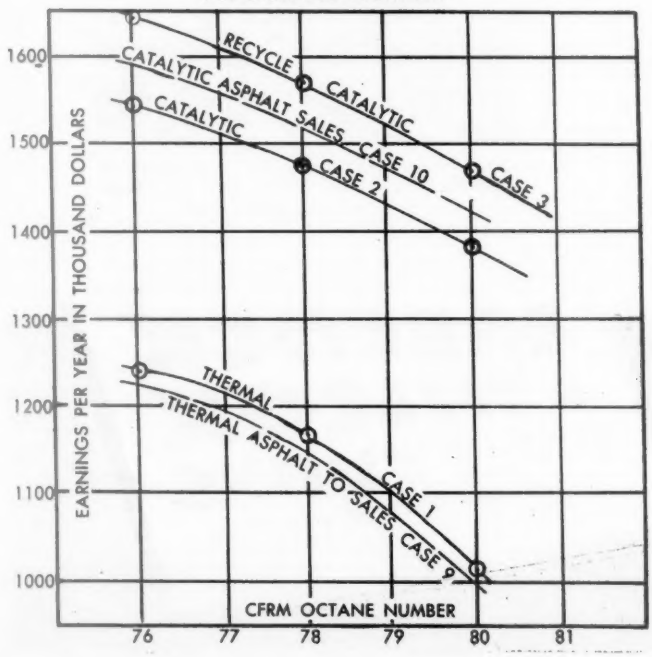

FIG. 4
EARNINGS END OF 10 YEARS AFTER INVESTMENT
RETIREMENT VS. OCTANE NUMBER

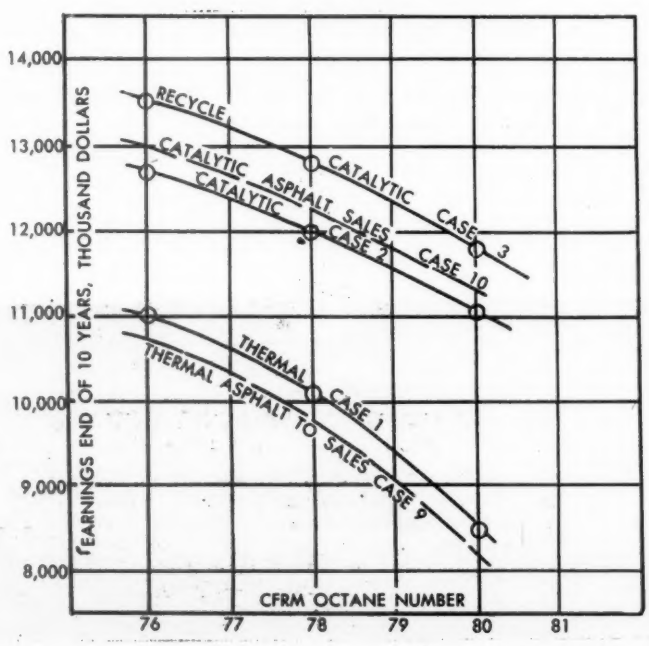

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FIG. 5.
DIFFERENTIAL RETIREMENT PERIODS VS. OCTANE NUMBER

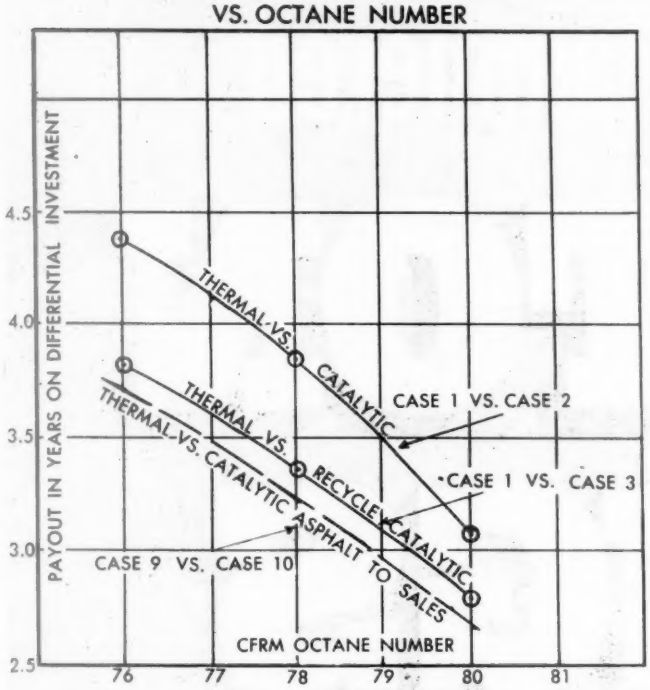


FIG. 6.
YEARLY EARNINGS AND 10 YEAR CASH POSITION VS. GASOLINE PRICE

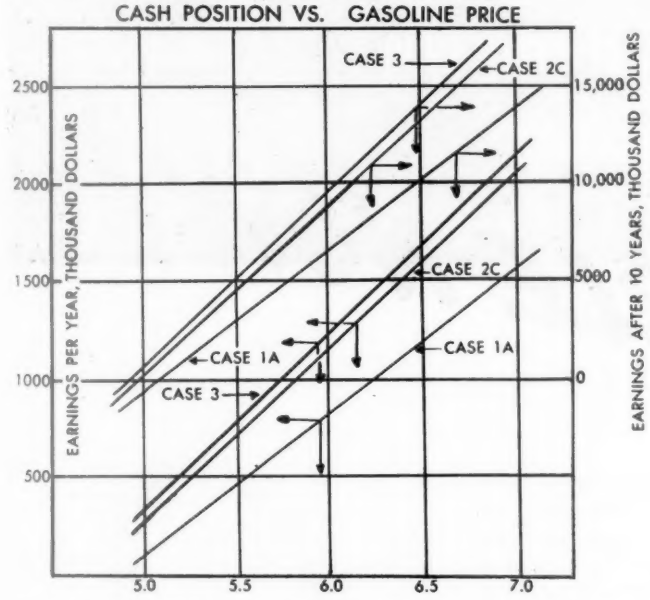


FIG. 7.
GASOLINE YIELD VS. BASE OCTANE AND TEL TO 80 CFRM

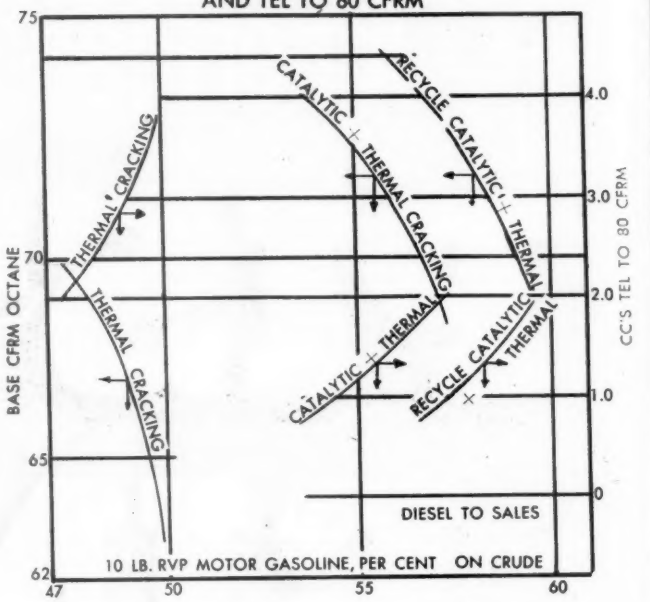
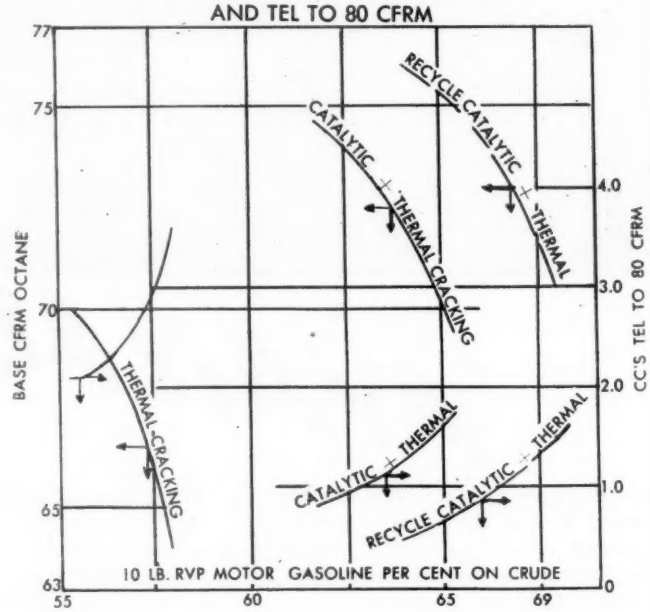


FIG. 8.
GASOLINE YIELD VS. BASE OCTANE AND TEL TO 80 CFRM



small integral TCC unit that will provide the answer to this perplexing problem. The goal was to develop a unit that could process 2000 to 3000 bbl. a day of charging stock catalytically with a per barrel investment and operating cost that would be comparable to that for larger plants. The design for these small plants has been completed and the small integral TCC unit is available to the industry.

Although these units embody a number of design simplifications, they are nevertheless in principle very similar to the large TCC units built for the war program. The enormous experience gained in the design and operation of the first units is, of course, reflected in the design and operating simplicity of this latest Houdry development. The simplifications include integral elevator design for both spent and regenerated catalyst. Further, it has been possible to eliminate vapor superheaters through increase in catalyst rates. In addition, inasmuch as the small units are of more compact design, it has been possible to reduce the overall height and simplify the structure substantially. Simplifications in this design result in savings both in operating and maintenance cost, and make it possible for refiners with small staffs to service units with their normal maintenance crews. The TCC kiln and reactor section of the small unit requires a space of about 40 ft. by 30 ft., making conversion of existing thermal crackers into catalytic units a very practical consideration. Fig. 1 shows an isometric sketch of the reactor kiln section of this type of TCC unit.

Heretofore, most methods of refinery octane improvement have depended upon sacrifice in gasoline output in order to improve quality. Catalytic cracking stands alone as a major refining tool with which high quality motor fuel may be obtained without sacrifice in ultimate output. In fact, catalytic cracking increases the overall yield of gasoline from a barrel of crude and reduces the yield of residual fuel oil. In this sense, it can be said that catalytic cracking in effect converts refinery residual fuel oil into

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TABLE 3—Summary of economics.
(Diesel fuel to sales)

Case No.		5A		5B		5C		6A		6B		6C		7		8	
Revenue	Cents per gal.	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day	B/CD	Dollars per day
10-lb. R.V.P. motor gasoline	6.250*	5,529	14,514	5,638	14,800	5,804	15,236	6,168	16,191	6,309	16,561	6,541	17,170	6,796	17,840	6,239	16,377
Kerosine	4.250	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678	1,500	2,678
No. 2 fuel	3.625															979	1,491
Residual fuel	2.145	2,264	2,038	2,242	2,018	2,200	1,980	1,611	1,450	1,589	1,430	1,547	1,392	1,228	1,105	949	854
Dry gas (FOE)	2.145	888	799	825	743	711	640	826	743	764	688	650	585	552	497	375	338
Excess butane	1.450	21	13					115	70	70	43			100	61	94	57
Total revenue			20,042		20,239		20,534		21,132		21,400		21,825		22,181		21,795
Operating costs																	
Crude	3.33	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000	10,000	14,000
Crude distillation		10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420	10,000	420
TCC cracking						4,755	627	4,755	627	4,755	627	4,755	627	9,510†	868	9,510†	868
TCC gas plant								226	235		235		235		247		247
Thermal cracking‡		7,200	859	6,640	813	5,600	693	8,307	631	4,747	587	3,707	428	2,808	344	1,500	107
Debutanization§			23		21		17		41		39		35		43		39
Catalytic polymerization		229	175	204	166	69	115	378	228	362	222	313	185	331	211	290	197
Gasoline inhibitor		5,529	6	5,638	6	5,804	6	6,168	6	6,309	6	6,541	7	6,796	7	6,239	6
Taxes, interest, insurance			252		240		210		450		441		422		465		405
TCC royalty								4,755	238	4,755	238	4,755	238	4,755	238	4,755	238
Thermal royalty		7,200	216	6,640	199	5,600	168	3,807	114	3,247	97	2,207	66	1,308	39		
Catalytic polymerization royalty		299	48	204	43	69	15	378	80	362	76	313	66	331	70	290	61
TEL to 76 CFRM (M cc's)		197	355	225	405	475	856	39	70	53	95	206	371	171	308	157	283
Total operating costs			16,354		16,313		16,500		17,140		17,083		17,100		17,260		16,871
Earnings, dollars per day			3,688		3,926		4,034		3,992		4,317		4,725		4,921		4,924
TEL to 78 CFRM (M cc's)		313	564	355	639	658	1,185	104	186	132	239	330	594	294	529	267	491
Earnings, dollars per day			3,479		3,692		3,705		3,676		4,173		4,502		4,700		4,726
TEL to 80 CFRM (M cc's)		488	878	533	959	878	1,580	207	373	252	453	495	890	457	822	406	731
Earnings, dollars per day			3,165		3,372		3,310		3,689		3,959		4,206		4,407		4,476
TEL to 82 CFRM (M cc's)		720	1,296	781	1,407	1,219	2,194	389	699	424	763	742	1,335	671	1,207	590	1,061
Earnings, dollars per day			2,747		2,924		2,696		3,363		3,649		3,761		4,022		4,146
Investments (process equipment only)																	
Crude distillation			$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000		$ 350,000
TCC catalytic section									725,000		725,000		725,000		900,000		900,000
TCC fractionation section									575,000		575,000		575,000		700,000		700,000
TCC gas plant			1,250,000		1,175,000		1,060,000		520,000		520,000		520,000		630,000		630,000
Thermal cracking and gas plant			240,000		225,000		125,000		800,000		740,000		625,000		520,000		100,000
Catalytic polymerization									320,000		310,000		285,000		295,000		275,000
Total			$1,840,000		$1,750,000		$1,635,000		$3,290,000		$3,220,000		$3,080,000		$3,395,000		$2,955,000

*Based on 75 per cent housebrand+25 per cent premium fuel. †Total feed—1:1 recycle. ‡Total for thermal cracking and gas plant. §Utilities only.

motor gasoline and at the same time improves the octane number of motor fuel by a substantial margin.

The value of catalytic cracking to a refiner will, of course, depend upon a number of considerations. Perhaps the most vital of these are two:

1. The relation of refinery gasoline price to residual fuel price.
2. The octane level required of house brand and premium fuels.

Although only a thorough analysis of his individual situation will give the refiner his final answer, a general study usually will indicate trends.

With this in mind, an attempt has been made to present herewith a general study of the economics of catalytic cracking for a refiner processing 10,000 bbl. per day of crude oil. There is included in this article a detailed analysis of all the cases studied, together with the basic assumptions employed to permit application of the general conclusions of this study to a particular problem.

The following basic cases have been considered:

1. Two-coil thermal cracking with varying depth of reforming and catalytic polymerization.

2. Visbreaking, once-through catalytic cracking, thermal cracking of the TCC cycle stock, and catalytic polymerization, including varying depths of reforming.

3. Visbreaking, recycle catalytic cracking, thermal cracking of the cycle stock and catalytic polymerization. Reforming was not employed.

4. Visbreaking, recycle catalytic cracking, and catalytic polymerization. Thermal cracking was not required as the light catalytic cycle stock was used as No. 2 fuel oil and the heavy catalytic stock in No. 6 fuel blends.

Those four cases have been based upon the assumption that 1500 bbl. per calendar day of kerosine and 1100 bbl. per calendar day of diesel fuel would be marketed as virgin stocks from the crude. A parallel series of cases (5 to 8) has been developed on the basis of cracking the virgin diesel fuel.

In addition, two cases (9 and 10) have been developed on the basis of producing asphalt for sales in order to ascertain the economic aspects of catalytic versus thermal cracking for this type of operation.

The price structure and utility value assumed are presented in the following table:

Stock	Price
Mid-Continent crude	$1.40/bbl.
Housebrand motor gasoline	6.25¢/gal.
Kerosine	4.25¢/gal.
Diesel fuel	3.625¢/gal.
No. 2 fuel	3.625¢/gal.
No. 6 fuel	$0.90/bbl.
Butanes	1.45¢/gal.
Fuel gas	$0.15/MM. B.t.u.
Steam	$0.24/M. lb.
Power	0.7¢/kw-hr.
Water (cooling)	0.5¢/M. gal.
Water (treated)	$0.15/M. gal.
Clay catalyst	$0.04/lb.

These prices, of necessity, are arbitrarily chosen. For an individual refiner

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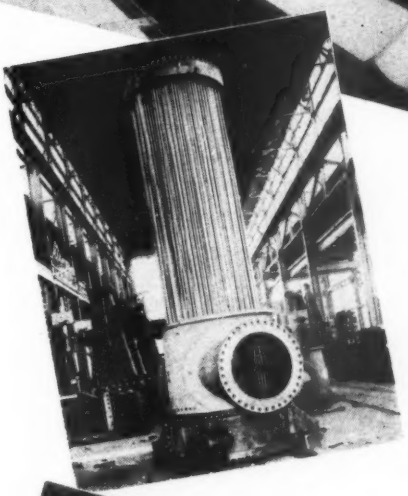

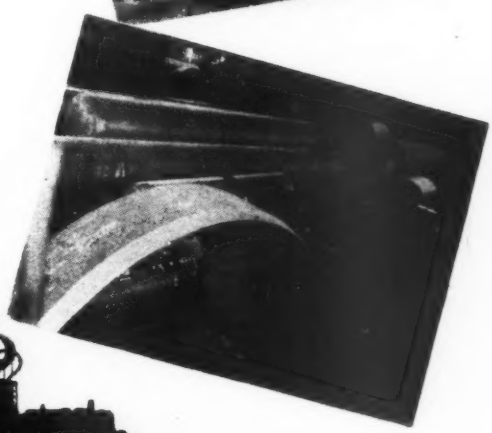

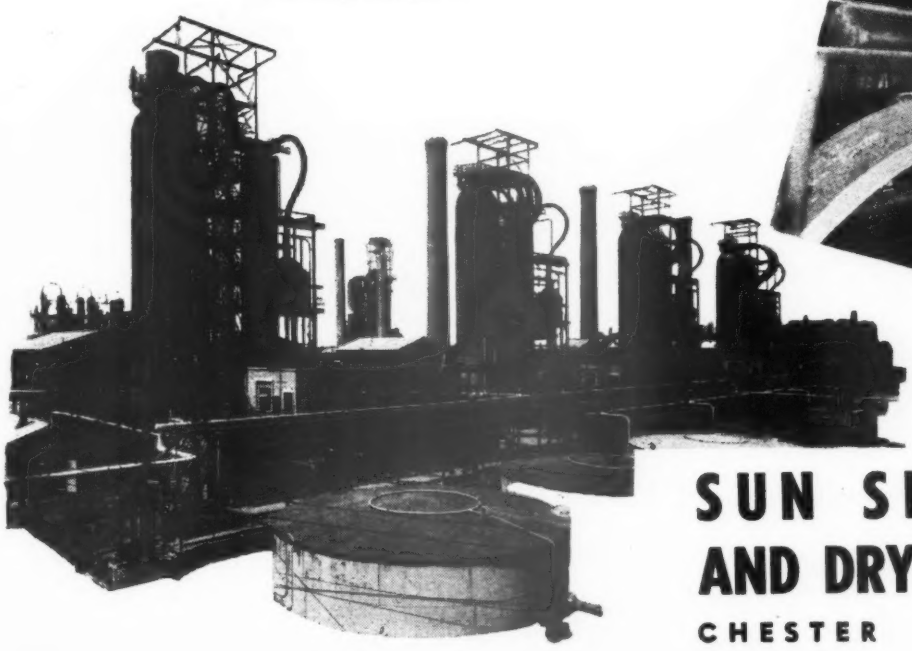

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TABLE 4
Summary of economics
(Diesel fuel to sales)

Case No.		9		10	
Revenue:	Cents per gal.	B/CD	Dollars per day	B/CD	Dollars per day
10-lb. R.V.P. motor gasoline	6.250*	4,710	12,364	5,708	14,984
Kerosine	4.250	1,500	2,678	1,500	2,678
Diesel fuel	3.625	1,100	1,675	1,100	1,675
Residual fuel	2.145	1,429	1,286	755	680
Asphalt	3.750	600	945	600	945
Dry gas (FOE)	2.145	670	603	445	400
Excess butane	1.450	36	22	..	..
Total revenue			19,303		21,362
Operating costs:					
Crude		10,000	14,000	10,000	14,000
Crude distillation		10,000	420	10,000	420
Vacuum reduction		3,000	150	1,500	118
TCC cracking		..	..	3,900	565
TCC gas plant		..	..	..	217
Thermal cracking†		5,500	675	1,799	355
Debutanization‡		..	18	..	34
Catalytic polymerization		188	150	244	181
Gasoline inhibitor		4,710	5	5,708	6
Taxes, interest, insurance		..	239	..	403
TCC royalty		..	..	..	195
Thermal royalty		..	165	..	54
Catalytic polymerization royalty		188	39	244	51
TEL to 76 CFRM (M cc's)		158	284	216	389
Total operating costs			16,154		16,988
Earnings, dollars per day			3,149		4,374
TEL to 78 CFRM (M cc's)		267	481	324	583
Earnings, dollars per day			2,952		4,180
TEL to 80 CFRM (M cc's)		396	713	479	862
Earnings, dollars per day			2,720		3,901
TEL to 82 CFRM (M cc's)		603	1,085	695	1,251
Earnings, dollars per day			2,348		3,512
Investments (process equipment only)					
Crude distillation			$ 350,000		$ 350,000
Vacuum reduction			330,000		240,000
TCC catalytic section			..		1,175,000
TCC fractionation section			..		..
TCC gas plant			..		490,000
Thermal cracking and gas plant			855,000		440,000
Catalytic polymerization			210,000		250,000
Total			$1,745,000		$2,945,000

*Based on 75 per cent housebrand and 25 per cent premium fuel.
†Total for thermal cracking and gas plant.
‡Utilities only.

to obtain a true picture, it is recommended that he substitute his own price structure.

The maintenance on topping units and gas plant was set at 3 per cent of the investment, whereas for catalytic cracking, thermal cracking, and catalytic polmerization a rate of 4 per cent was established. The taxes, interest and insurance were set at 5.0 per cent of the investment. Estimated royalty rates were used for catalytic and thermal cracking and catalytic polymerization processes and are shown in the detailed tables.

The basic yields used for the various processes are shown in Tables 8, 9, and 10. Overall commodity balances, capacities of the various processing units, and clear octane numbers with lead requirements for various octane levels of the motor gasoline are shown in Tables 5, 6, and 7. The gasoline price of 6.25 cents a gal. was arrived at on the basis of 75 per cent of housebrand gasoline at 6 cents and 25 per cent of premium fuel at 7 cents a gal. At the 80-octane level, this would mean that housebrand fuel would have a 78 and the premium fuel an 85 octane number.

In every case except where asphalt is produced, it has been assumed that the reduced crude would be visbroken in order to minimize residual fuel. In these cases with catalytic cracking, the total vaporizable effluent from the viscosity breaking operation flows directly to the catalytic cracking unit as is illustated in the typical flow diagram, Fig. 2. There are, of course, other processing methods (such as propane deasphalting or vacuum flashing) that can be employed in order to charge a heavier stock to the catalytic plant. Although the flexibility of TCC units is such that these heavy charging stocks can be readily handled, the aforementioned methods of processing (vacuum flashing and propane deasphalting) were not considered in the economic studies presented herein except in those cases involving the manufacture of asphalt, for it is believed that expensive means of charge stock preparation cannot be justified unless outlets for specialty products such as asphalt are available. The gasoline yield advantage generally obtained through processing reduced crude to pitch by distillation or deasphalting is virtually eliminated if it becomes necessary to blend the pitch back to marketable fuel oil.

A summary of economics, showing yearly earnings, retirement periods, and earnings at the end of 10 years during which period the investment has been retired, is presented in Table 1. Cases 1, 2, 3, 4, 9, and 10, all involving the production of diesel fuel for sales, have been considered in this series of cases for economic comparisons and, although a series of cases parallel to 1, 2, 3, and 4, shown in Table 1, has been developed on the basis of cracking the diesel fuel, these cases have not been summarized as in Table 1 for the same general conclusions are reached. Complete details showing the development of the economics for all these cases are presented in Tables 2, 3, and 4. In cases 1 and 2 (also cases 5 and 6), shown in Tables 2 and 3, involving all thermal cracking and once-through catalytic cracking, respectively, the effect is shown of varying the depth of reforming from zero, as indicated in Case 1C, to a maximum of 1600 BPGD, as indicated in Case 1A, with Case 1B as an intermediate.

For each case studied, a depth of reforming was selected for comparison which resulted in maximum dollar return, provided a lead limit of 2 cc. per

TABLE 5
Summary of yields and process equipment
(Diesel to sales)

Type operation	Thermal cracking, variable thermal reforming			Catalytic cracking+visbreaking, thermal cracking TCC cycle, variable thermal reforming			Recycle cat. cracking, visbreaking+thermal, no reforming	Recycle cat. cracking, visbreaking, no reforming, no thermal
Case No.	1A	1B	1C	2A	2B	2C	3	4
Products	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD
10-lb. R.V.P. gasoline	4,740	4,843	4,975	5,346	5,491	5,722	5,941	5,516
Kerosine	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Diesel fuel	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
No. 2 fuel	..	..	..	..	..	..	..	658
Residual fuel	2,067	2,045	2,003	1,391	1,369	1,327	1,078	949
Excess butane	20	..	..	132	74	..	70	74
Dry gas (FOE)	698	636	522	685	623	509	478	329
Crude run	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Process equipment	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD
Crude distillation	11,100	11,100	11,100	11,100	11,100	11,100	11,100	11,100
Thermal cracking gas oil	..	..	..	1,870	1,870	1,870	1,100	..
Thermal cracking red cr.	5,000	5,000	5,000	1,665	1,665	1,665	1,665	1,665
Thermal reforming	1,775	1,155	none	1,775	1,155	..	..	..
TCC	..	..	..	4,060	4,060	4,060	8,120*	8,120*
Catalytic polymerization	200	170	..	345	308	227	288	254
Octane Nos.								
CFRM+0 cc TEL	69.8	68.2	62.7	74.0	72.7	68.3	69.2	69.0
TEL to 76 CFRM	0.75	1.10	2.10	0.13	0.30	0.85	0.75	0.75
TEL to 78 CFRM	1.20	1.60	2.90	0.35	0.65	1.30	1.20	1.20
TEL to 80 CFRM	2.00	2.40	3.80	0.73	1.15	1.90	1.80	1.75
TEL to 82 CFRM	2.90	3.50	5.30	1.30	1.80	2.75	2.60	2.50

*Total feed—1:1 recycle ratio.

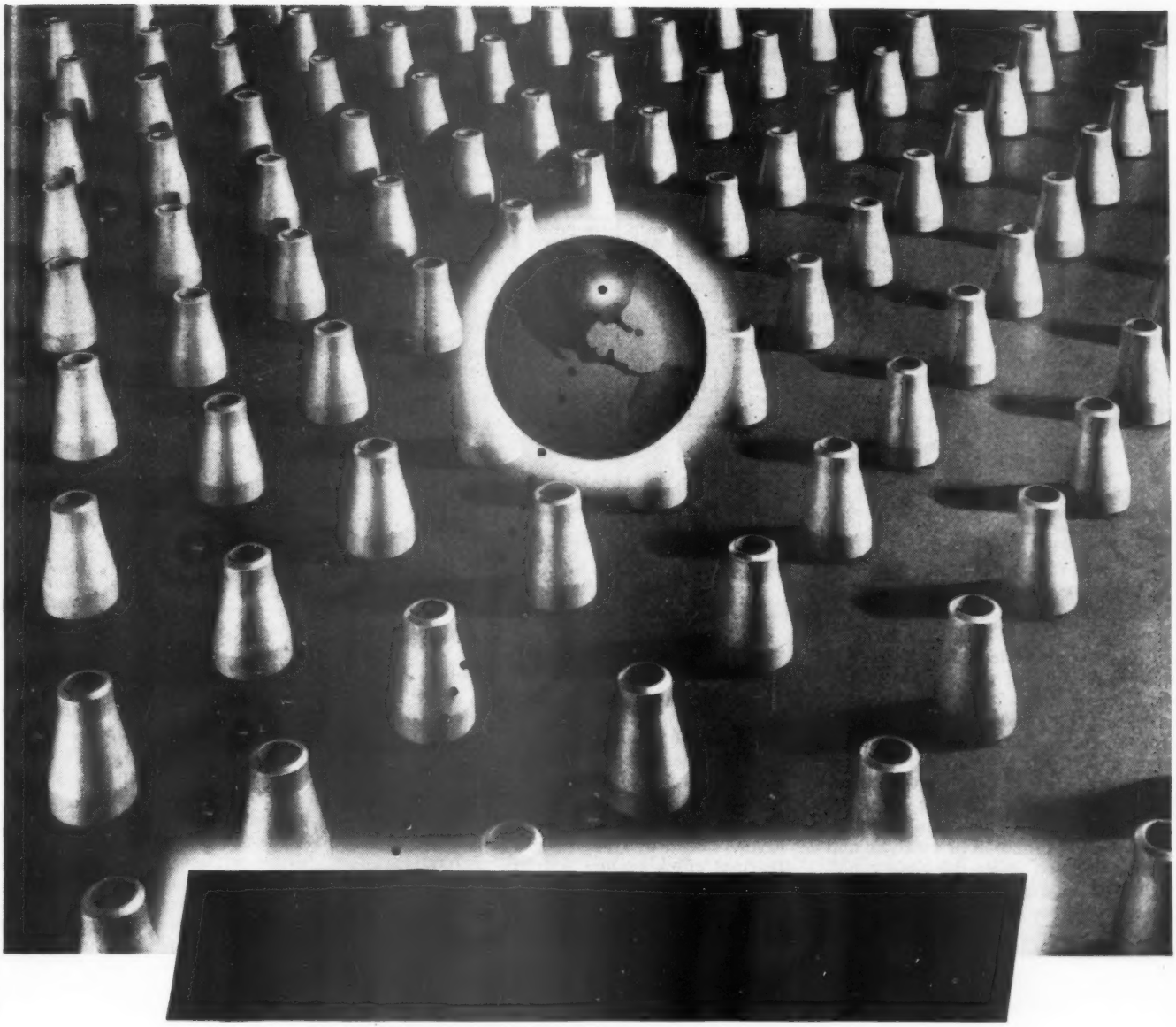

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TABLE 6

Summary of yields and process equipment

(No diesel to sales)

Type operation	Thermal cracking, variable thermal reforming			Catalytic cracking+visbreaking, thermal cracking TCC cycle, variable thermal reforming			Recycle cat. cracking, visbreaking+thermal, no reforming	Recycle cat. cracking, visbreaking, no reforming
Case No.	5A	5B	5C	6A	6B	6C	7	8
Products	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD	B/CD
10-lb. R.V.P. gasoline	5,529	5,638	5,804	6,168	6,309	6,541	6,796	6,239
Kerosine	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
No. 2 fuel	..	..	..	..	..	..	..	979
Residual fuel	2,264	2,242	2,200	1,611	1,589	1,547	1,228	949
Excess butane	21	..	..	115	70	..	100	94
Dry gas (FOE)	888	825	711	826	764	650	552	375
Crude run	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Process equipment	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD	B/SD
Crude distillation	11,100	11,100	11,100	11,100	11,100	11,100	11,100	11,100
Thermal cracking gas oil	..	..	..	2,450	2,450	2,450	1,444	..
Thermal cracking red. cr.	6,225	6,225	6,225	1,665	1,665	1,665	1,665	1,665
Thermal reforming	1,775	1,155	..	1,775	1,155	..	..	..
TCC	..	..	..	5,290	5,290	5,290	10,548*	10,548*
Catalytic polymerization	254	200	77	437	402	348	368	322
Octane Nos.								
CFRM+0 cc TEL	69.8	68.7	63.9	74.6	73.3	69.4	70.4	70.3
TEL to 76 CFRM	0.85	0.95	1.95	0.15	0.20	0.75	0.60	0.60
TEL to 78 CFRM	1.35	1.50	2.70	0.40	0.50	1.20	1.03	1.02
TEL to 80 CFRM	2.10	2.25	3.60	0.80	0.95	1.80	1.60	1.55
TEL to 82 CFRM	3.10	3.30	5.00	1.50	1.60	2.70	2.35	2.25

*Total feed—1:1 recycle ratio.

TABLE 7

Summary of yields and process equipment.

(Diesel and asphalt to sales)

Type operation	Thermal cracking and reforming	Catalytic cracking, Thermal cracking TCC cycle
Case Nos.	9	10
Products	B/CD	B/CD
10-lb. R.V.P. gasoline	4,710	5,708
Kerosine	1,500	1,500
Diesel fuel	1,100	1,100
Residual fuel	1,429	755
Asphalt	600	600
Excess butane	36	..
Dry gas (FOE)	670	445
Crude run	10,000	10,000
Process equipment	B/SD	B/SD
Crude distillation	11,100	11,100
Vacuum reduction	3,330	1,665
Thermal cracking gas oil	4,330	2,000
Thermal cracking reduced crude	..	..
Thermal reforming	1,775	..
TCC	..	4,330
Catalytic polymerization	210	271
Octane nos.		
CFRM+0 cc TEL	69.9	68.6
TEL to 76 CFRM	0.80	0.90
TEL to 78 CFRM	1.35	1.35
TEL to 80 CFRM	2.00	2.00
TEL to 82 CFRM	3.05	2.90

gal. was not exceeded. This limit was imposed because of the generally poor performance shown with highly leaded fuels; and because of the desirability from the standpoint of flexibility in refining operations of reaching a given motor fuel octane number with a minimum of TEL.

A series of charts has been prepared to illustrate the relation of catalytic and thermal cracking under the basic conditions assumed. Fig. 3 illustrates the relative earnings per year for thermal and catalytic cracking. It will be noted that over the entire range of octane numbers the earnings for catalytic cracking far exceed those for comparable thermal crackings; also, as might be expected, recycle catalytic cracking involving the highest production of catalytic gasoline also shows the highest earnings.

Fig. 4 has been constructed to show the value of catalytic cracking in relation to the increased investment required. Earnings above investment have been determined for a period of 10 years for both thermal and catalytic cracking cases. The difference between straight thermal cracking and recycle catalytic cracking at the end of 10 years is shown to be approximately $2,500,000 at a 76-octane level and $3,250,000 at an 80-octane level. It will be noted that no comparison is shown above 80-octane number, for such an operation would be impractical without excessive use of tetraethyl lead for straight thermal cracking.

Fig. 5. illustrates, as a function of octane number, payouts of the differential investment between catalytic and thermal cracking. These payout periods are, of course, of only relative significance, for a careful analysis of such individual refinery situation is necessary before the true picture can be determined. Investment figures are predicated upon normal construction costs, and although it is recognized that such may vary with local labor conditions and individual refinery specifications, these figures used in this report are consistent and therefore comparable. Often utilization of existing equipment in conversion

FIG. 9.

TEL REQUIREMENTS VS. OCTANE NUMBERS

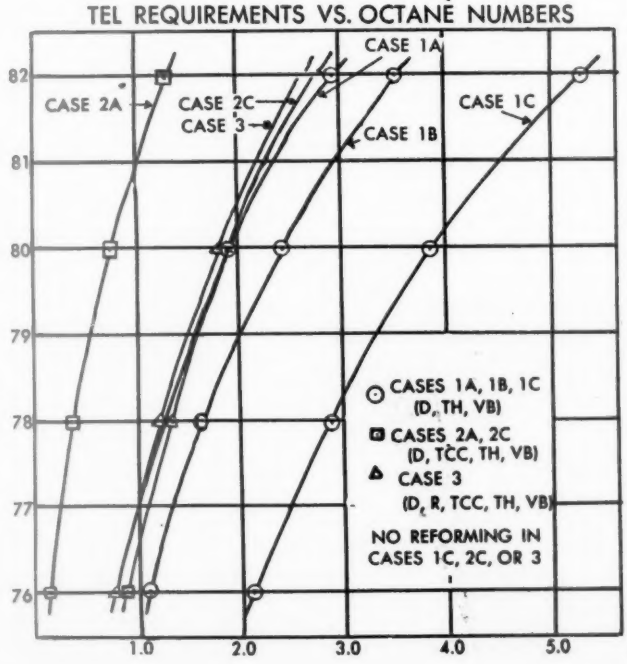

TABLE 8

Thermofor catalytic cracking yields.

Case Nos.	2	6	3	7	10
Tar separator charge, BPCD					
Diesel fuel	..	1,100	..	1,100	..
Topped crude	4,500	4,500	4,500	4,500	4,500
Visbreaker gas oil	655	655	655	655	..
TCC recycle	..	..	3,655	4,755	..
Total	5,155	6,255	8,810	11,010	4,500
Tar separator bottoms	1,500	1,500	1,500	1,500	1,500
Vacuum gas oil	..	..	..	..	900
TCC reactor charge, BPCD	3,655	4,755	7,310	9,510	3,900
Yields based on fresh charge*, volume per cent					
Debutanized motor gasoline	42.0	41.6	56.0	55.5	42.6
Catalytic gas oil	46.0	46.5	27.0	27.5	46.2
Isobutane	3.7	3.8	7.0	7.0	3.7
Normal butane	1.5	1.5	2.0	2.0	1.5
Butylenes	4.7	4.6	5.9	5.8	4.9
Propylene	3.3	3.3	3.9	3.8	3.4
Dry gas (FOE)	7.6	7.3	8.9	8.3	7.8
Properties of fresh reactor charge*					
Gravity, deg. API	29.5	31.0	29.5	31.0	26.5
Aniline no., °F.	185	175	185	175	190
Vacuum distillation					
10 per cent	570	520	570	520	570
50 per cent	740	670	740	670	780
90 per cent	915	890	915	890	980

*Includes visbreaker gas oil but excludes TCC recycle.

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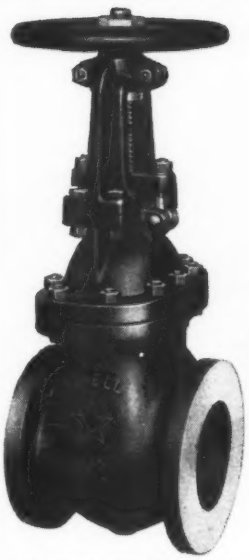
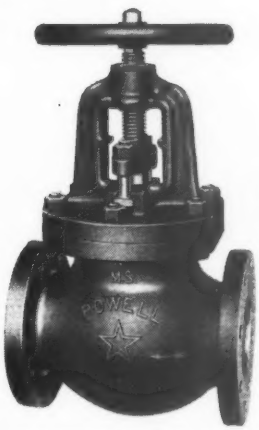
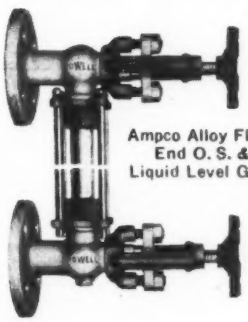


125-pound Iron Body Gate Valve with Ampco Alloy Trim.

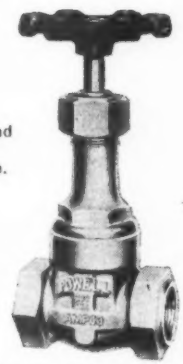


125-pound Iron Body Globe Valve with Ampco Alloy Trim.

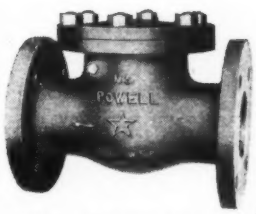
Ampco Alloy Flush Bottom Tank Valve.



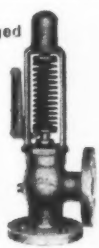
Ampco Alloy Flanged End O. S. & Y. Liquid Level Gauge.



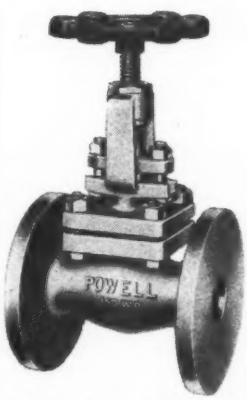
200-pound Ampco Alloy Screwed End Gate Valve.



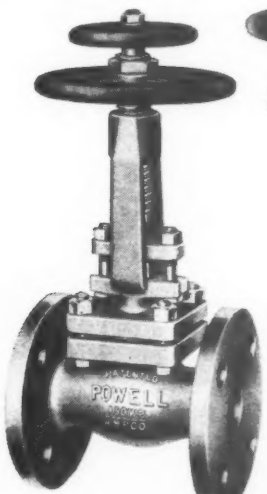
150-pound Ampco Alloy Swing Check Valve.



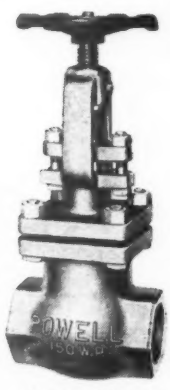
Ampco Alloy Flanged End Angle Relief Valve.



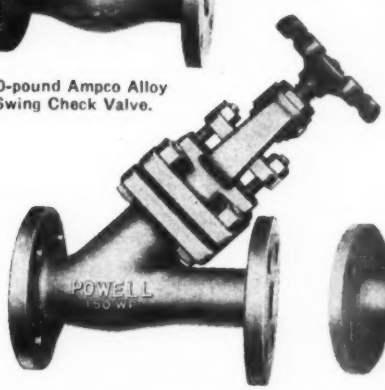
150-pound Ampco Alloy Flanged End O. S. & Y. Globe Valve.



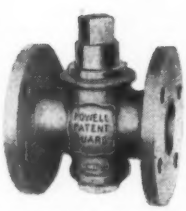
150-pound Ampco Alloy O. S. & Y. Globe Valve, equipped with Powell Patented Seat Wiper.



150-pound Ampco Alloy Screwed End O. S. & Y. Gate Valve.



150-pound Ampco Alloy Flanged End O. S. & Y. "Y" Valve.



Ampco Alloy Flanged End Ground Key Plug Cock.

POWELL VALVES

TABLE 9
Thermal cracking yields.

Cases	1	5	2, 3, 4, 6, 7, 8	3, 7	9	10
Charge stock, BPCD						
Gas oil	..	..	..	..	3900	..
Reduced crude	4500	5600	1500	..	..	..
Catalytic gas oil	..	..	..	987 & 1308	..	1799
Gravity, deg. API	25.0	27.0	15.5	25.0	26.5	30.0
Yields, volume per cent						
Debutanized motor gasoline	44.1	47.7	13.1	36.0	50.0	41.5
Isobutane	0.7	0.7	0.3	1.0	0.9	0.9
Normal butane	2.0	2.4	0.9	3.2	2.4	3.0
Butylenes	2.1	2.5	0.7	2.8	2.7	2.6
Propylene	1.9	2.2	..	2.5	2.2	2.8
Visbreaker gas oil	..	..	43.7	..	..	..
Fuel oil	44.5	39.3	41.3	46.5	35.0	42.0
Dry gas, weight per cent*	8.5	9.0	2.3	13.0	12.0	10.0

*C_3 and lighter.

TABLE 10
Reforming yields.

Cases	1A, 2A	1B, 2B
Naphtha charge, B/CD	1040	1600
Charge octane no.	46.0	49.0
Yields, volume per cent		
Debutanized motor gasoline	76.4	76.4
Isobutane	1.2	1.2
Normal butane	3.1	3.1
Butylenes	4.3	4.3
Propylene	3.3	3.3
Fuel oil	4.0	4.0
Dry gas, weight per cent	15.0	15.0
Debutanized motor gasoline octane no.	68.0	69.0

of thermal to catalytic cracking will reduce investments very substantially and make the payout even more attractive.

Fig. 6 shows the effect of refinery gasoline price on earnings per year and earnings after 10 years taken at the 80-octane level.

Figs. 7 and 8 illustrate the octane yield relationship for thermal cracking, once-through catalytic and recycle catalytic cracking. These graphs make it evident that not only is there a large advantage in gasoline octane number and TEL requirement for catalytic cracking but there is also a very substantial advantage in overall gasoline yield. For example, when producing 80-octane number motor gasoline containing 2 cc. TEL, there appears to be a yield advantage of 12-13 per cent for recycle catalytic cracking over thermal cracking only. Fig. 9 illustrates lead requirement, as a function of octane number, for several of the cases studied. These curves emphasize again the value of catalytic cracking in producing high octane number gasolines of low TEL content.

Delayed coking for the preparation of gas oil charge is a highly attractive process for those refiners who desire a minimum of heavy fuel oil and who can dispose of the petroleum coke.

The studies presented in this article lead to a number of interesting and practical conclusions:

1. TCC catalytic cracking is now available for the small refiner. Studies have been prepared which show that the process is feasible for the refiner processing 3000 or more bbl. per day of crude oil.

2. The competitive market for motor fuel points toward higher gasoline octane numbers in the future. Catalytic cracking will, in many cases, be the only means of economically reaching those competitive levels.

3. Earnings from catalytic cracking at a given octane level are, in nearly every case, sufficiently greater than for thermal cracking to justify its installation.

4. Reduction in yield of residual fuel makes for greater flexibility in meeting many local market conditions.

5. Substantial investment savings can be achieved in many cases by using existing thermal equipment. ★ ★ ★

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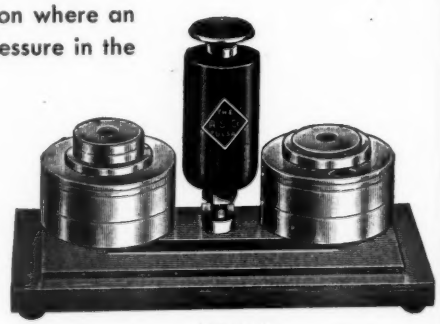

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Intervals of Pressure, Lbs.	**1**	**0.1**	**1**	**0.1**	
HIGH PRESSURE TYPE—Range lbs.,	**50 to 1,000**	**2,000**	**2,500**	**3,000**	**3,500**
Intervals of Pressure, lbs.,	**1**	**1**	**1**	**1**	**1**

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ELEMENTS OF GAS LIFT PRACTICES

By L. P. CONNER*

EXCLUSIVE

Gas lifting was originally introduced to the oil fields as a means of producing extremely large volumes of fluid at economical costs. Many oil wells produced so much water that they were plugged because it was impossible to produce enough fluid to pay the costs of operation. Some operators found that using gas-lift with the proper submergence and the correct pressures and volumes they could produce their "water" wells at high rates. It was also found that by producing large quantities of fluid they could recover enough oil to make continued operation profitable.

Some operators experienced great difficulty in arriving at the correct submergence, however, and substituted perforations in the tubing string for errors in calculations in order to lower high kick-off pressures. It was found that unless the perforations were of the right size, and spaced properly that the wells had either high ratios or did not produce enough fluid.

Kick-off valves and automatic flow valves were gradually developed as means of extending the life of primary recovery on large "water" wells, then came "prorated" flows. Wells that had a small percentage of water present would often go dead under proration when shut in and yet have sufficient gas pressure to flow if they could be produced at rates that would keep the water moving. Many operators installed perforated kick-off valves and automatic valves for the purpose of causing the well to begin flowing when the tubing gate was opened after the well had been shut in for a period of days or weeks.

● **Intermitters.** The manufacturers of gas lifting equipment then began working on intermitting devices that by proper application could produce a well to depletion or to the economic limits.

Pressure controlled intermitters, hydrostatic intermitters, wire line intermitters, and surface controlled means of raising and lowering a tubing string that in turn opens or closes a valve have been developed. Almost every system employs two general types of installations: (1) Valves above a packer, and (2) valves or means of producing below a packer.

● **Principles and practices.** The principles involved in the term gas lifting consists of the introduction of a gas under pressure to a column of fluid in a well at some point or points that will enable the gas to remove the fluid from the well to the flow tanks. This flowing action is induced by the gas expanding from a high to a low pressure.

For most purposes it may be assumed that the gas expands isothermally, and this may be calculated by the use of Boyle's law of the behavior of gases under pressure. By applying Boyle's law it is possible to calculate the theoretical results of expansion. Then, efficiencies can be determined from measurement of actual results in the field. A common base for calculations is essential, and entails the reduction of all gas volumes to cubic feet at 14.4 lb. absolute pressure.

It is important that the correct volume of pressure gas be admitted to the fluid to obtain the maximum efficiency when using automatic flow valves or intermitting valves. The amount of gas admitted is usually controlled by some means on the surface, usually by a timing device. The volumes of gas required will be different for various fluids and depths. The volumes usually needed by each unit of a series of automatic valves are those that have been found to be sufficient for the particular size of tubing and type of fluid to be handled. For example, a unit for 2½-in. tubing will need more gas than the same unit for 2-in. tubing, and, likewise, a unit designed to handle a large percentage of water will have a greater capacity than one designed to handle all oil. The volumes or capacities of the various types of automatic valves will be different for the same type fluid and tubing size due to the difference in construction and operation of the valves.

● **Automatic operation.** The data necessary to calculate a gas life installation using automatic valves are: Available gas, its pressure and volume; volume of fluid to be handled; type of fluids (frothy mixture of oil and gas or compact oil column, and percentage of water); size tubing; fluid level, and, if available, the draw-down rate of the well. With these data it is usually possible to install an efficient operating string of valves. There are two systems of gas lifting, one is the so-called open system, the other is referred to as a closed system. An open system consists of a string of tubing with a series of valves placed at various intervals in the tubing string. The closed system has a string of tubing and a series of valves the same as an open system, but has a packer placed between the lowest valve and the bottom

Table 1—Record of a typical installation

Date installed—8-28-37
Potential—642 bbl. Ratio 242 cu. ft. per bbl.
Date of test—11-16-37

T. D. 4519 ft.
7-in. 24-lb. set at 4311 ft.
2-in. EUE 10-thd. tubing
Gravity—350°API

Static condition before test:

Tubing pressure, lb. per sq. in.	Casing pressure, lb. per sq. in.	Fluid level		Shut-in hr.	Bottom hole pressure. 1300
		Tubing	Casing		
370	370	1325	1325	24	1568

First producing gradient:

Test date allowable, bbl.	Hours flow	Total production, bbl.	Input ratio, cu. ft. per bbl.	Casing pressure, lb. per sq. in.	Bottom hole pressure, 1300	Working fluid level	Lowest valve open
43	1½	46.92	190	435	1205	2500	No. 6

Hr. flow	Total production, bbl.	Input ratio, cu. ft. per bbl.	Input pressure, lb. per sq. in.	Bottom hole pressure 1300	Working fluid level	Lowest valve open	Water
2	37.95	258	460	1150	2700	No. 7	none

Valve installation. Bottom of tubing—4507 ft.
Valves at (ft.): 886—1193—1500—1777—2035—2299—2545—2791—3037—3222—3407—3592.

Results shown by data compiled:

Time	Input pressure	Tubing pressure	Casing pressure	Choke	Casing fluid level	Production, bbl.	
						Well	Total
8:50	S.I.	370	370	....	1325		
10:00	open well						
11:30	435	60	435	⅛ in.	2500	22.42	24.5–46.92
1:30	460	65	460	⅛ in.	2700	34.45	3.5–37.95

Ratio		Pressure—1300
Input	Output	
		1508
190	...	
258	304	1205
		1150

*Engineer, Merla Tool Corporation.

of the hole. Open systems are used in wells having high fluid levels and large capacities. Closed systems are used in wells of low capacity.

With regard to calculations necessary for an installation of automatic flow valves, it is important to know the fluid level of the well, for it is one of the most essential factors for determining the number of units required for a particular job. The fluid level may be determined by the use of a float or a recording bottom-hole pressure bomb. When using a pressure bomb it is a good plan to take readings at various depths, so the operator will be able to compute the gas-oil contact point, the oil-water contact point, and also learn whether any sediment is present at the bottom reading depth. Then, with the fluid level determined, the gas pressure known, and an open system to be installed, it is a simple process to find the top flow valve by the following method:

Subtract the known gas pressure from the fluid pressure reading as determined by the pressure bomb. Then, calculate the fluid level at this pressure. The top valve should then be installed approximately 150 ft. above this point so that it will be possible to make the well flow with the known pressure. If the valve had been placed at the pressure level the fluid in the tubing would balance the casing pressure and nothing would happen, however, by moving the valve above the pressure level the casing pressure at that point is from 50 to 75 lb. per sq. in. greater than the fluid pressure.

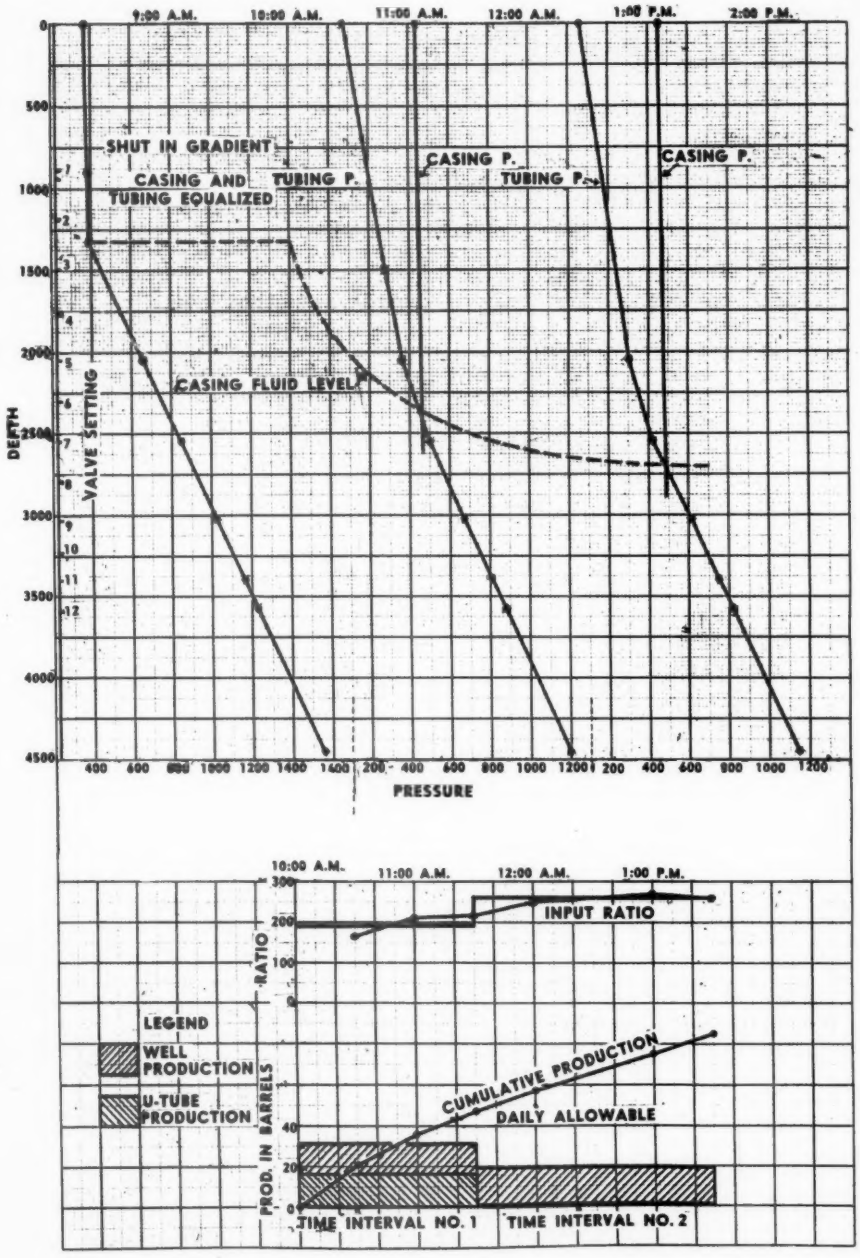
Example: 2-in. tubing depth 4500 ft. in 7-in. casing, available gas pressure 450 lb. per sq. in. Bottom hole pressure readings, 110 lb. per sq. in. at 1500 ft., 280 lb. at 2000 ft., 450 lb. at 2500 ft., 620 lb. at 3000 ft., 815 lb. at 3500 ft., 1035 lb. at 4000 ft., and 1255 lb. per sq. in. at 4500 ft. Then, maximum bottom-hole pressure (1255) less available gas pressure (450) = 805 lb. per sq. in. Therefore, fluid level with 450 lb. per sq. in. applied pressure would be about 2500 ft. from the surface and top valve should be placed at approximately 2350 ft. from the surface.

Before going further it might be well to explain the pressure settings of valves. Most all types of automatic valves have what is called a differential setting. This means that either the opening or closing pressure, or both, is so many pounds per square inch under any applied casing pressure. For example, a valve that has 100-lb. differential will open when it has a fluid load of 400 lb. per sq. in., if the casing pressure is 500 lb. per sq. in.; or the valve will open under a fluid load of 300 lb. per sq. in., if the casing pressure is 400 lb. per sq. in. The closing pressure will be in the same ratio. When an automatic valve has a sufficient load to cause it to open there is rapid transfer of pressures. The tubing pressure will become the same as the casing pressure at that point. The pressure caused by the fluid, however, is less than the applied gas pressure and the fluid begins moving as more gas is admitted under the fluid load and the gas will cause the fluid to follow the course of least resistance, which is upward. The expanding gas accomplishes the work of lifting the fluid and lightens the load of fluid in the tubing. As the fluid moves faster, an increasing differential pressure is formed across the valve. When this differential reaches the set differential pressure of the valve it will cause the valve to shut off the incoming gas. Therefore, it is apparent that in an automatic string of flow valves, it is possible—and usually happens—that two or more of the valves could supply gas at the same time. If the capacity of the valve is large enough, it is possible to admit enough gas that the friction set up by the flow is such that the closing differential of the valve or valves cannot be established and a steady gas flow with very little fluid will result. Should the valves have a small capacity they will transfer the gas from the casing to the tubing, but this gas will bubble through the fluid without doing any appreciable amount of work other than causing the head of fluid to surge in the tubing. In regard to the spacing between the valves, a common practice among field engineers has been to run a graduated string. By this it is meant that the top valves have a wider spacing than the bottom valves, and the distance between successive valves gradually decreases toward the bottom.

In most wells the average valve spacing in feet is approximately equal to the pressure of the fluid that would equal the differential pressure of the valve in feet. In other words, if the fluid caused a pressure of 33 lb. per sq. in. per 100 ft. of height, the spacing for 100 lb. per sq. in. differential valves would be approximately 300 ft.

The top valves may have a wider spacing due to the fact that it is easier to displace the fluid from the upper levels

FIG. 1. Graphic record of flow test data.



• When the time comes to pierce the earth 4 miles in search of "pay"—it's a comfort to know that Link-Belt has chain brawny enough, tough enough, efficient enough to do the job.

It is a comfort to know that, since chain was first used in the oil industry, Link-Belt engineers have never ceased matching chain design and construction to the ever-changing needs and techniques of drilling. As your new drilling problems arise—you will find Link-Belt research has anticipated them.

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and the amount of decrease in the spacing will depend upon the characteristics of the particular well. If the well has a high fluid level and a low productivity factor the spacing can be farther apart than if the well has a high level and a high productivity factor. It is seldom that the spacing between the bottom valves is less than about 240 ft. except in very large water wells. Then the spacings may be as low as 180 ft. The best settings may be found by trying different spacings in comparable wells in a given area.

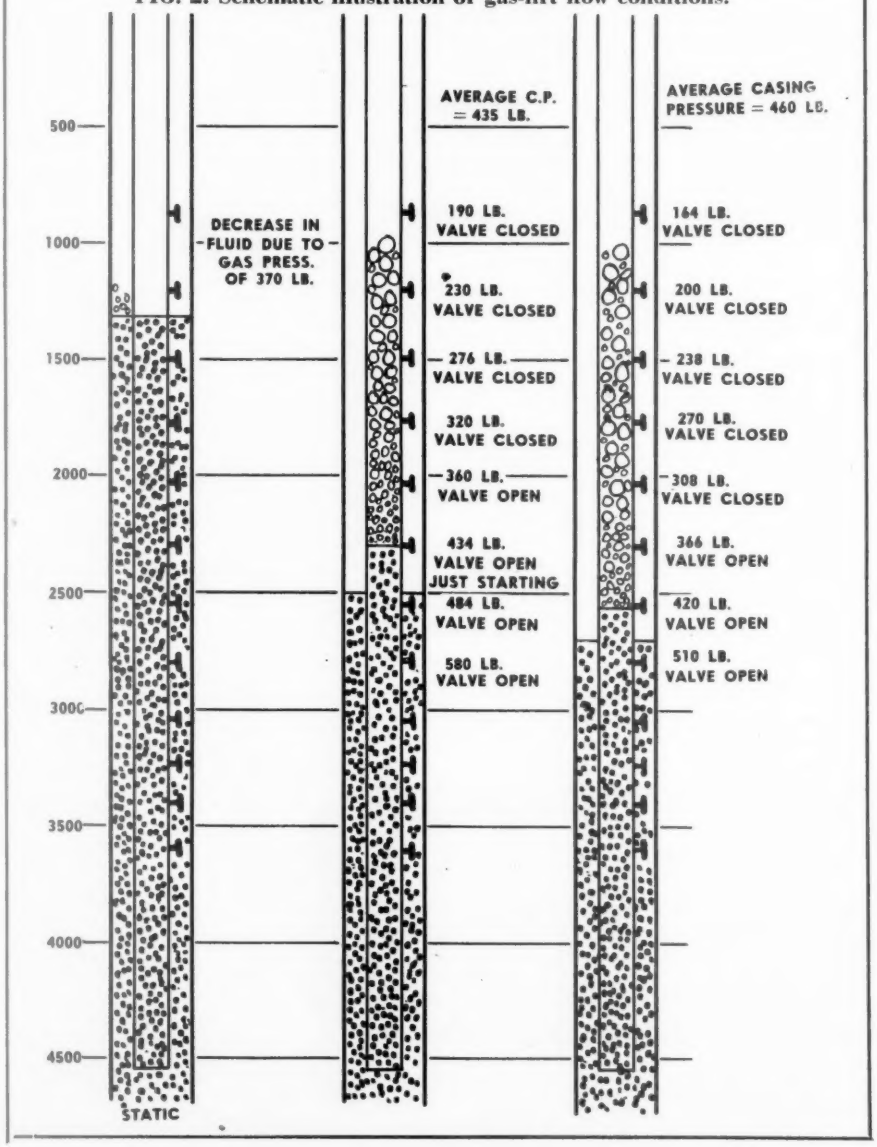
A suggested valve spacing plan for the well conditions given previously would be as follows:

● **Conditions given.** Total depth, 4525 ft.; tubing depth 4500 ft., maximum bottom hole pressure at 4500 ft., 1255 lb. per sq. in.; fluid gradient 34 to 44 lb. per sq. in. per 100 ft.; calculated fluid level 3288 ft. from the bottom or 1212 ft. from the surface; production required per day 250 bbl. fluid; tubing size 2 in. upset; casing 7 in. O.D. set at 4325 ft.; water percentage 50 per cent, and available outside gas at 450 lb. per sq. in.

TABLE 2—Flow test data

Time	Pressure in well		Tubing pressure, lb. per sq. in.	Casing pressure, lb. per sq. in.	Oil production, bbl.	Input gas, cu. ft.	Input ratio, cu. ft. per bbl.	Output gas, cu. ft.	Output cu. ft. per bbl.
	Depth,	Lb. per sq in.							
8:50	0	370	370	370					
8:55	886	390							
8:58	1500	456			Well shut in 24 hr. Pressures measures under static conditions.				
9:01	2035	662							
9:04	2545	847							
9:07	3037	1024							
9:10	3407	1162							
9:13	3592	1236							
9:24	4469	1568							
10:00	Tubing gate opened and gas turned into casing (430)								
10:15	886	....	20–60	435					
10:18	1500	276	65	435					
10:21	2035	260	60	435					
10:24	2545	484	65	435					
10:27	3037	666	60	435					
10:30	3407	802	60	440	29.84	3400	164		
10:33	3592	870	60	440					
10:38	4469	1205	60	440					
11:00			55	450	14.56	3000	206		
11:30			55	460	11.52	2600	226		
12:00				470	9.08	2300	253	2800	308
12:30				475					
12:45			60	480					
12:50	886	..	65	480					
12:53	1500	..	65	480					
12:58	2035	308	65	480					
1:00			65	485	19.00	4800	253	5800	305
1:01	2545	420	60	485					
1:04	3037	608	60	485					
1:07	3407	748	65	485					
1:10	3592	812	60	485					
1:15	4469	1150	65	485					
1:30			60	490	9.37	2400	256	2900	309

FIG. 2. Schematic illustration of gas-lift flow conditions.



● **Suggested valve spacing plan.** As before, the top valve would be installed approximately 2350 ft. from the surface. The other valves should be installed at approximately the following depths 2690, 3000, 3280, 3560, 3840, and the bottom valve at about 4090 ft. The rest of the tubing would be used as an anchor to maintain a fluid seal between the tubing and casing. This is not a fixed spacing plan to be followed, but is a pattern that may be altered to suit the particular well. It is based on experience with similar wells in several areas. So far as is known there is no definite mathematical formulae for calculating the exact location of each valve in the tubing string. There are entirely too many variable factors to consider.

Operation. After the valves are installed and the well is connected to the gas supply, the well begins to "kick off" as the tubing is opened to the separator or pit. The casing pressure may build up in a hurry without causing the well to flow. What happens in a case like this is simply that the sudden application of gas causes the fluid in the tubing to move upward as a relatively solid slug. The probable explanation of this movement, sometimes referred to as "U-tube" action, is that the tubing pressure at the top valve rapidly becomes equal to the pressure of the gas in the casing at that point, but insufficient gas enters the tubing to lighten the column of oil above the valve. If the operator would leave the well for a time it would probably begin to flow. If the pressure had been applied slowly, however, the fluid in the tubing would probably have remained at its original level, and the fluid level in the annulus would have receded until it reached the top valve, then the gas in the casing would have begun to enter the fluid in the tubing and caused the well to flow. Therefore, the position of the top valve is important in determin-

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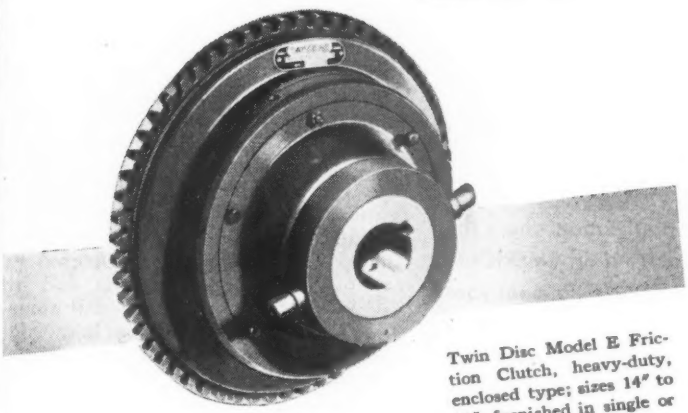
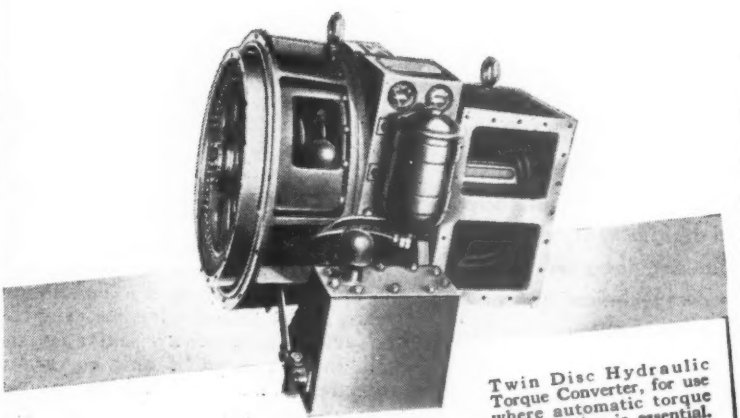
Model P Air-Actuated Clutch permits remote control without complicated linkage system. Requires less shaft space, thereby permitting closer shaft bearing center distances.



Twin Disc Model E Friction Clutch, heavy-duty, enclosed type; sizes 14" to 42"; furnished in single or two-plate assemblies.



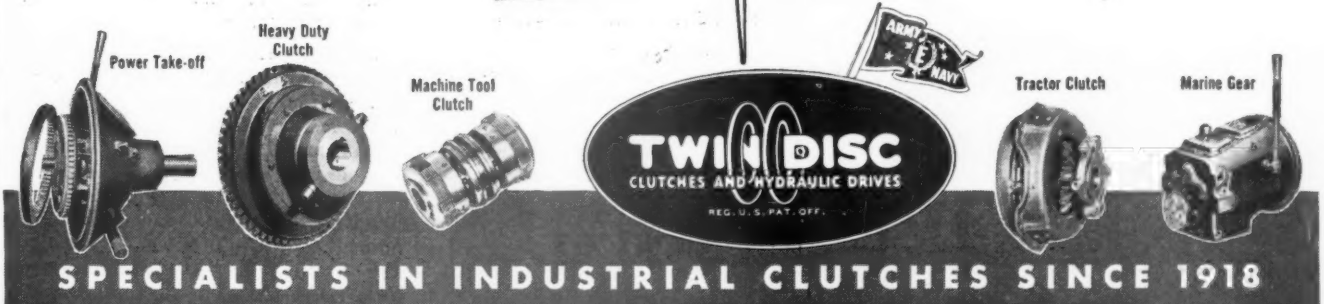
Twin Disc Hydraulic Torque Converter, for use where automatic torque multiplication is essential.

If you have a new unit which requires a connecting link between driving and driven parts—whether that link be a friction clutch, a hydraulic coupling or a torque converter—the Twin Disc Clutch Company offers you these advantages:

1. A broad line of standard friction clutches, hydraulic couplings and hydraulic torque converters*, covering the widest variety of industrial applications.
2. Over a quarter-century of continuous specialization in the building of industrial clutches . . . in developing streamlined production methods which assure uniform quality with lowest practical cost.
3. Adequate records on which performance, operating characteristics and wear-life may be accurately predicted.
4. A competent group of field and factory engineers, skilled in the application of both friction clutches and hydraulic drives, backed by a service organization of 9 factory branches and 31 parts stations.

That is why so many nationally known machinery and equipment manufacturers have found they can speed production, assure efficient performance and reduce post-sale service by standardizing on Twin Disc Clutches and Hydraulic Drives. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

*Lysholm-Smith type.



SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

ing the pressure necessary to cause a flow. If, in the example, it is desirable to begin flowing the well with a casing pressure of 300 lb. per sq. in. the top valve should be placed approximately 1800 ft. from the surface. The position of the other valves could be adjusted accordingly from this valve. To reach a depth of 4000 ft. with this lower available gas pressure, it would be necessary to add another valve to the string.

After the well begins flowing satisfactorily and there are apparently no further difficulties, the operator may return at some later time and find that the well is blowing a spray of fluid. The following conditions could be the cause: (1) A hole in the tubing, (2) valves having too much gas capacity and too close together, (3) too much back pressure on the tubing, (4) valves stuck open or (5) the well might be flowing around the bottom of the tubing. If the valves are stuck, it is sometimes possible to shake them loose by "rocking" the well; that is, closing in the tubing until the maximum pressure is reached, and then opening the tubing as quickly as possible, repeating the operation several times.

If the well appears to be dead, it can usually be started by "rocking" as just described except that in this case the tubing pressure should be released slowly, and, if possible, a back pressure should be held on the tubing for a period of time as the well flows. This static condition with no flow is usually caused by the valves being spaced too far apart, or some of the valves being stuck in the closed position.

Sometimes when valves are installed in a well that has been swabbed considerably, or has had a packer sleeve torn up in the process of removal, a considerable amount of erratic action may be expected from the valves. Small pieces of swab rubbers or packing may lodge in the valves. In some cases these fragments may be removed by rocking the well. In other cases it may be necessary to pull the valves and clean them of all the foreign material.

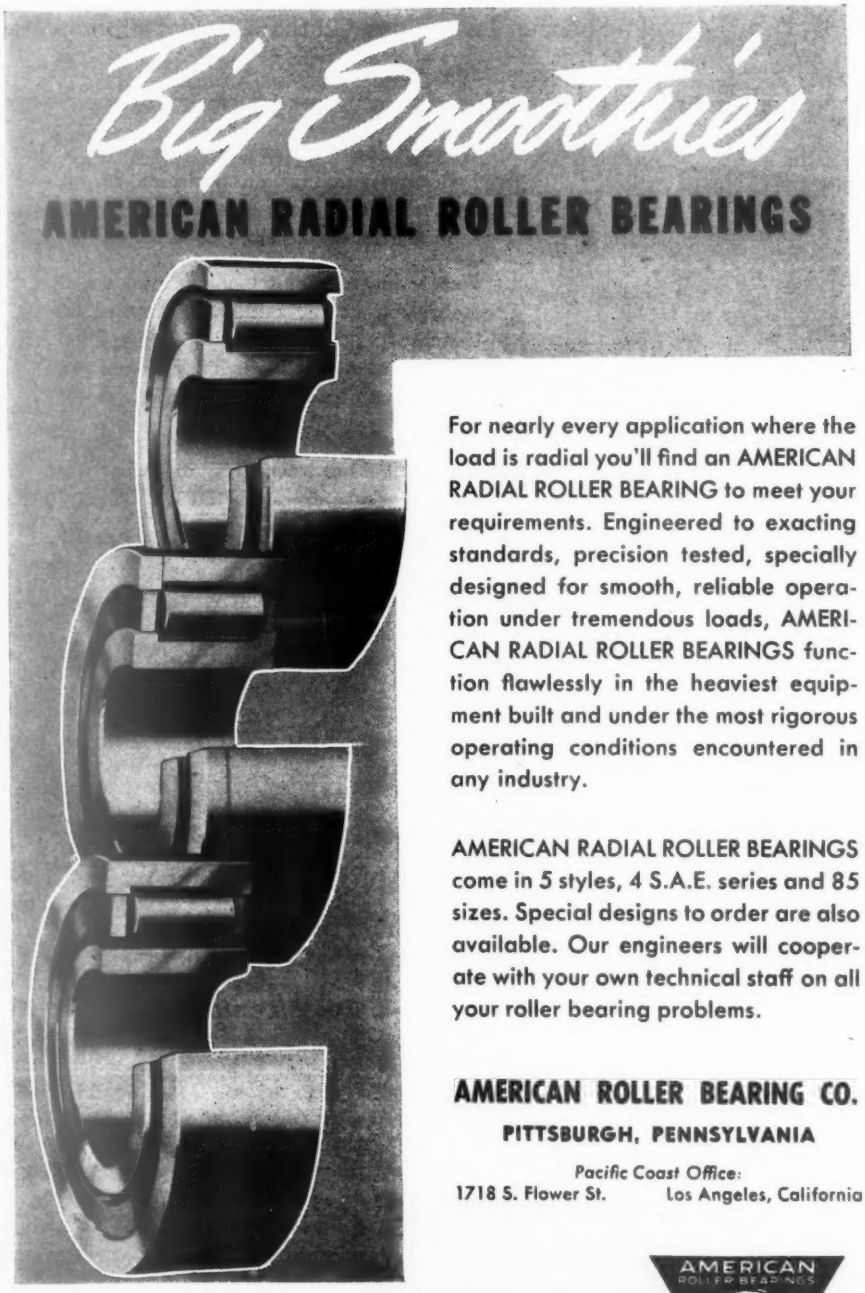
Many wells have been found to be blowing around the bottom of the tubing. Without removing the tubing and running a closed system, the trouble may be remedied by trying to produce the well with a lower casing pressure, or produce the well at intervals by "stop cocking" either manually or by the use of a surface time control.

It is not considered good practice to produce a well with automatic flow valves against a small choke, because the choke is a means of holding a back pressure and this pressure will have a tendency to cause the valves to remain open due to the artificial load introduced by the back pressure. There are, however, quite a number of wells that have automatic valves in them that are producing against a comparatively small choke. These wells are considered exceptions to the general rule and are usually limited to those that will almost flow by themselves due to both high bottom-hole pressure and high productivity indices.

Some interesting data may be obtained from gas-lift wells by the use of various meters, pressure gages, and bottom-hole pressure recorders. The accompanying data and curves made from an actual test of a well illustrate the above statement.

It is apparent from the data and curves obtained that the following takes place. First, there is a very definite decline in operating bottom-hole pressure with a proportional decline in operating fluid level. This proves that the valves actually displace the fluid from the annulus and gradually lower the working fluid level. Second, it is possible by means of the data obtained to calculate the actual productivity factor of the well and the rates of flow at various pressures. Third, it can be proved whether more than one valve is in operation at one time and whether too many valves are installed.

For this particular installation, it can be shown that the top valve is not needed to start the well flowing, and that it is not necessary to have valves numbers 9, 10, 11, and 12 to obtain the allowable. It would have been a more economical installation, therefore, to have used only 7 valves. When the well declined to the point that it would not make the allowable production, the installation could have been changed advantageously to meet the new conditions. ★ ★ ★



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LIKE A "300" BOWLER

FORM-SET ROPE IS *Relaxed*

There was the bowler who, on the threshold of the magic 300, went out for a walk before his final roll. Tension was high, but the walk around the block settled his nerves. On the all-important roll, the pins went down and the perfect game was his . . . *because he'd relaxed!*

There's a great deal of that same relaxed quality in Form-Set rope. Form-Set is Bethlehem's preformed, and wire rope in the preformed construction has been relieved of many internal stresses and strains; freed of the locked-in tension that sometimes shortens rope life.

The helical wires don't have a nervous urge to straighten themselves out. Cut a section of Form-Set rope and see what happens. *Nothing.* The wires and strands lie just as they were. They don't pop loose or "wicker."

What's all this add up to? First, longer life (savings for *you*). Second, easy handling (something your *crews* will like). Third, better performance (that's what everybody wants).

Remember—no matter what grade of Bethlehem rope you buy, you can get it in the *relaxed* Form-Set construction.

When you think WIRE ROPE

. . . think BETHLEHEM

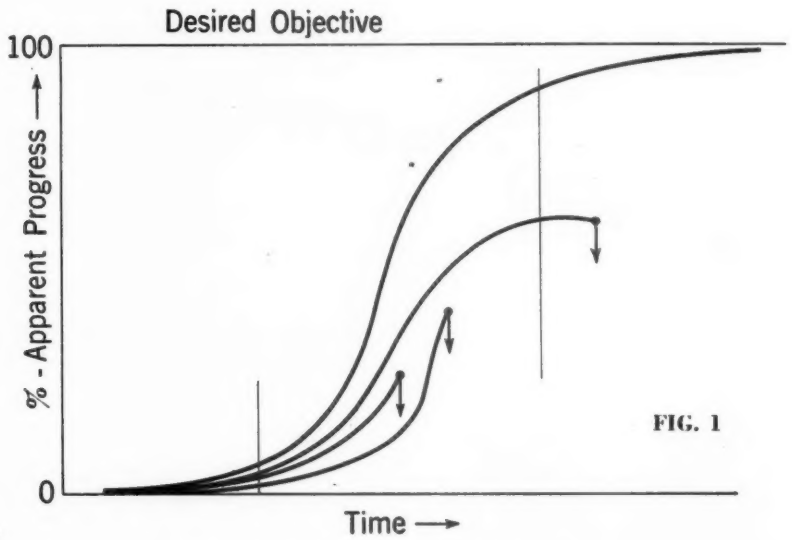


FIG. 1

Trend of A Development in Time

DEVELOPMENT WORK TO PREVENT CORROSION

B. B. MORTON

Development and Research Division
The International Nickel Company

For a long period of time research and development work was dependent upon the momentary flashes of some genius. These geniuses often looked and acted so in keeping with a pattern that a definite mental picture took form of a person capable of producing new ideas. According to American ideals, the picture was not always flattering.

EXCLUSIVE

In the United States, as perhaps nowhere else in the world, the matter of research and development has gradually been removed from the field of moon-gazing and installed on a fairly sound production basis. This process has been described by Lippman and others as "Invention of Invention" and has been outlined in a rule to the effect that "An answer to nearly any technical problems can be obtained by the application of sufficient manhours." The atomic bomb's development can be viewed as a classic demonstration of this rule. There exist certain limitations to the efficient application of this rule.

In order to employ the rule just stated, certain logical steps in development work appear advisable. It would appear, in sequence, the following steps are indicated:

1. *The problem must be recognized.*
2. *The problem must be outlined.*
3. *The need for a solution must be felt.*
4. *Work must be authorized and undertaken.*

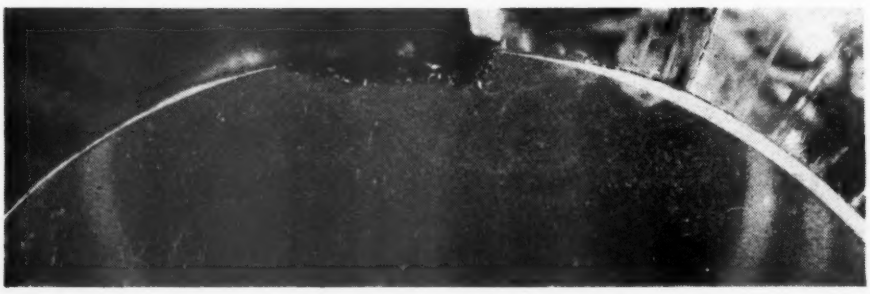
An economic study must be made concurrent with the research work, but should not act as a brake at the early stage. There is a tendency to make an economic estimate and from its results to pre-judge a development project. It is well to have some definite results from the development work to guide the economic survey before a conclusion is reached as to the financial aspects of the project.

● **Petroleum industry.** The petroleum industry has such diversified problems, especially corrosion problems, that it presents a broad field of endeavor for the many persons interested in solutions of these problems.

● **Development work—general.** To a person financing or underwriting a research project leading toward the development of a method or material, the trend of the work will be in keeping with the curves of Fig. 1. In this curve the "Percentage of progress towards an objective" is plotted against "Time".

It will be noted that three broad sections of the curve are indicative of stages of progress. In the first stage time is

FIG. 2. Worn section of nickel-plated sucker rod. Note absence of galvanic effects.



consumed with but little apparent progress. In this stage the program is laid out, equipment assembled, and contacts leading to future tests are made. In the second stage the project is launched and commercial installations are made; often some manufacturer has decided to back the project and a number of preliminary sales are made. In the third stage the conflicting forces of sales and competition are felt and the project assumes its place, which in some cases may be oblivion. It is here indicated (Fig. 1) that many projects are launched, but few survive. This, the writer believes, is a common experience. The writer once undertook a study of the reasons for some failures of such ventures, but found them too numerous and varied to allow any generalization.

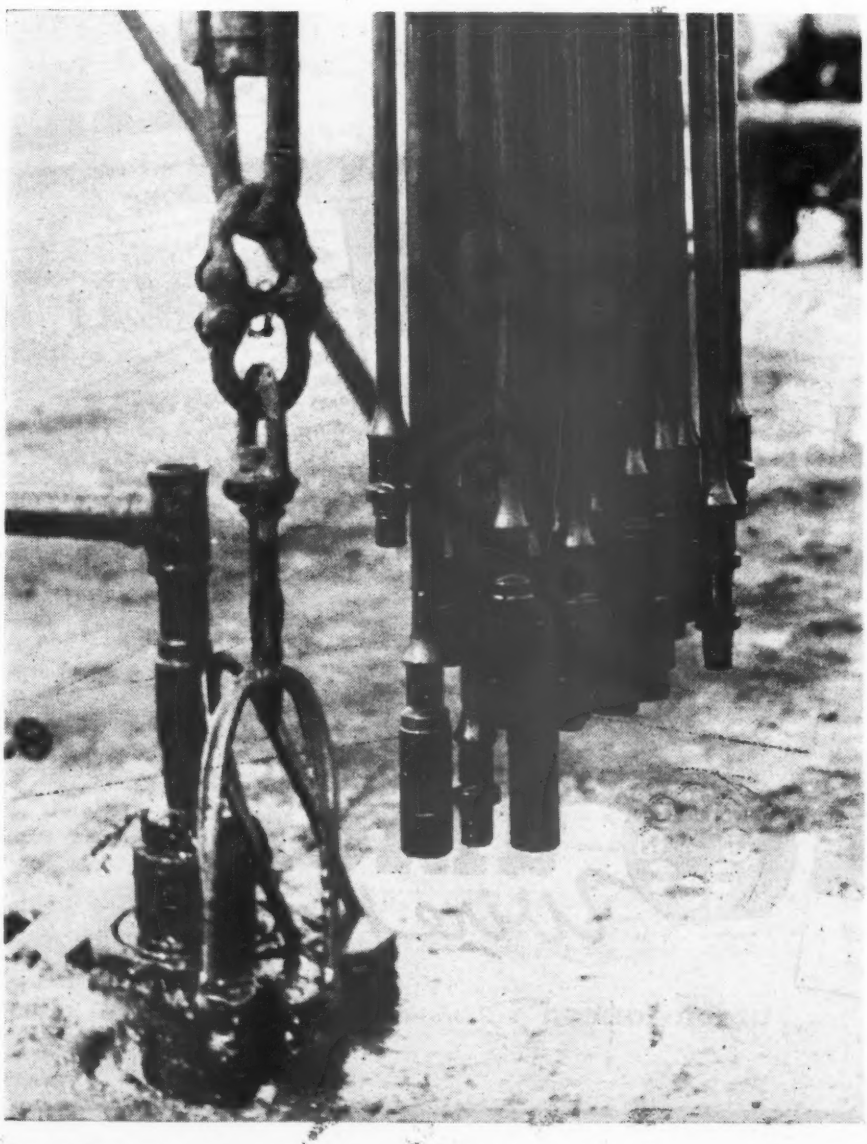
It now seems timely to consider some special cases applicable to the petroleum industry.

● **Special sucker rod materials.** There has always been felt a need for a good and fairly inexpensive sucker rod material. The term "inexpensive" is relative in this case and is used to express the fact that the unit cost of producing the paying liquid is a minimum. This tends to eliminate first cost, athough this elimination has to be proved.

The mechanical requirements of a sucker rod material are that it shall possess a high order of corrosion fatigue resistance under well conditions in order to reduce breakage and, if possible, a high yield point so that fishing jobs are facilitated if breakage occurs. A high order of corrosion resistance is desired and, in some cases, other properties have been subjugated to this requirement of corrosion resistance.

Two methods of providing superior properties in sucker rods were investigated. In one case a nickel plating was applied to the outstanding alloy steel used for sucker rods. This steel is the nickel-molybdenum alloy known as SAE 4620, or by a number of trade names. The other method was to use a heat treatable form of Monel (approximately ⅔ nickel, 1/3 copper). In both cases the high order of resistance of nickel to sulphide and brine corrosion formed the basis of the selection.

FIG. 3. K-Monel sucker rods in West Texas service.



In the case of the nickel plated rods, a long period of time was expended in finding a source to plate 25-ft. rods and a longer period of time was expended by a well known plating company in working out an impervious plating. The rods were installed in corrosive brine wells in Arkansas and in corrosive sulphide wells of West Texas. In the Arkansas wells the rods struck the walls and eventually wore through to failure. (Fig. 2). This stressed the need for a suitable protector or guide and stimulated other research at another laboratory. The rods in West Texas apparently gave an excellent account of themselves and after 6 years the sample viewed by the writer was in excellent condition.

A large amount of investigation accompanied the development of the nickel plated rods. One item developed was that the rods had an endurance limit (fatigue limit) of the nickel plate that was lower than that of the steel in air, but nearly double that of the steel in a corrosive well environment.

The most noteworthy but fairly typical result of this type of investigation was that Corronizing, a method for protecting steel, was born from the investigations connected with the development of a method of applying an impervious plate. The possibilities of Corronizing became so great that primary interest was lost by the originators in sucker rods. Many investigators will recognize this development of a favorable "side" product of more value than the project under pursuit.

The development of the "K" Monel rods would give a different shape to the curve shown (Fig. 1), as representative of a typical development, for the groundwork of developing a hardenable, corrosion-resistant, alloy had been accomplished. The properties recommending "K" Monel (hot rolled and aged) were: High yield strength (100-125,000 lb. per sq. in.), good ductility (30-20 per cent in 2 in.), and high fatigue resistance under corrosive well conditions (approximately 45-50,000 lb. per sq. in.). The fatigue resistance, i.e., endurance limit, is apparently the same in air and under corrosive well conditions.

The problems surrounding the development of "K" Monel sucker rods were largely mechanical and involved forging, upsetting, and heat treating to obtain desired properties without introducing stress-raising bends, etc. A leading sucker rod manufacturer of Tulsa undertook the fabrication of a test string that was installed in West Texas about 4 years ago. There they have given excellent service and have apparently suffered no corrosion in a well that destroyed steel strings in from 6 to 8 months. Other and heavier strings of "K" Monel have been ordered and installed.

These developments have contributed two methods of obtaining longer life for sucker rods. The economics in this case favor the higher priced rods, i.e. the K-Monel rods.

(Continued on Page 140)

THE DOCTOR HAS PRESCRIBED . . .

EVERYTHING WE EAT AT SOME TIME OR OTHER MUST TRAVEL A ROAD OR HIGHWAY
ONE OF THE PRODUCTS OF THE SHORTER WORK WEEK WILL BE TIME – TIME FOR HEALTHFUL HIGHWAY TRAVEL BY MILLIONS
DOCTORS ARE UNABLE TO REACH THOUSANDS OF FAMILIES QUICKLY
43% OF THE COMMUNITIES IN THE UNITED STATES RELY EXCLUSIVELY ON MOTOR CARRIERS.
THE SOCIAL AND RELIGIOUS LIFE OF THOUSANDS AND THOUSANDS OF FAMILIES IS STIFLED BY SECONDARY ROADS THAT ARE IMPASSABLE MUCH OF THE TIME.
POSTWAR CARS ARE ALREADY COMING OFF PRODUCTION LINES. HIGHWAYS AND STREETS MUST BE BUILT SPEEDILY TO AVOID CONGESTION
Rx viae durae atque bonae sine fine

union Wire Rope

union-formed is *Preformed* TO OUTPERFORM

ACCIDENTS DUE TO ANTIQUATED HIGHWAYS CRIPPLE AND KILL THOUSANDS YEARLY.
Rx viae durae atque bonae sine fine
LOW, NARROW AND LIGHT BRIDGES CONSTITUTE UNSAFE, OFTEN UNUSABLE LINKS IN OTHERWISE ADEQUATE ROADS.
Rx viae durae atque bonae sine fine
EMPLOYMENT OFFICE
NO HELP WANTED
AS MUCH AS 91% OF EVERY DOLLAR EXPENDED FOR HIGHWAYS AND STREETS IS ULTIMATELY PAID OUT AS WAGES AND SALARIES.
STEADY EMPLOYMENT OF ALL KINDS AT GOOD WAGES
NOTHING WILL BENEFIT THE HEALTH AND WEALTH OF OUR COUNTRY AND CITY FOLKS AS WILL FREE, SPEEDY AND SAFE ACCESS TO EACH OTHER VIA GOOD HIGHWAYS.
Rx viae durae atque bonae sine fine
PROMPT AUTO REPAIRS
FEW CARS AND TRUCKS SERVE THE FULL LIVES OF WHICH THEY WILL BE CAPABLE WHEN ALL ROADS ARE HARD AND GOOD.
CAR
Rx viae durae atque bonae sine fine
CLOSED
MILLIONS OF MEN BESIDES SERVICE STATION ATTENDANTS DEPEND UPON HARD AND GOOD HIGHWAYS TO GIVE THEM A LIVELIHOOD.
Rx viae durae atque bonae sine fine

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HARD AND GOOD ROADS WITHOUT END

Not only has the doctor written this prescription—he has earmarked funds to pay half the cost of a 3 year course of medicine.

The other half (1½ billion dollars) must be raised by 48 patients. The will to get well of a majority of them is at a low ebb. Only 7 states have sufficient plans for the first year of the program. Plans for highway projects ready to let amount to less than half the medicine apportioned by the doctor for the first year to say nothing of the other 2½ years.

A lot of nursing is yet necessary. If a large highway construction program is to be gotten under way in 1946, then everyone in the industry and profession must turn nurse and help the doctor coax the patients to take their medicine. Otherwise, men will go unemployed, traffic will snarl and the next dose of medicine will be plenty bitter for lovers of the American way of life to take.

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☐ Send a Free copy of book entitled "The Road Ahead"
☐ Send a Free copy of book entitled "Put Your Town on the Air Map"

Name.....

Firm.....

Address..... *City*..... *Zone*... *State*.....

E-45

FIG. 4. K-Monel non-magnetic drill collar in directional drilling operation in California.

(Continued from Page 137)

● **Non-magnetic drill collars and subs.** A development that could be represented by a curve that showed no perceptible progress for a long time centered around finding a suitable material for non-magnetic drill collars and subs.

A material was required that had low magnetic properties, which would be retained at well temperatures and under rough treatment. High mechanical properties were required with especial emphasis on fatigue resistance. K-Monel was indicated.

After considerable preliminary work on the effects of cold working upon the magnetic properties, several subs of "K" Monel were ordered and placed on trial. The results apparently were satisfactory, for the number of units ordered and the diameter of the units have increased. The present units, more than 6 in. in diam., are specified to have a yield strength of 75,000 lb. per sq. in., and permeability of 1.02 (air taken as 1.0). The endurance limit of this alloy ranges from 45,000-55,000 lb. per sq. in. in the as forged condition. This range is only slightly improved with heat treatment of the alloy to improve its strength. On the other hand, the value is apparently not reduced by corrosive well conditions.

The use of "K" Monel collars is expected to greatly facilitate orientation and directional work.

● **Linings for vessels.** One of the most important metallurgical requirements for petroleum refineries is to find suitable corrosion-resistant material to line the various vessels used in refinery operations. As the refineries turned to chemicals and special additives for 100-octane gasoline the requirements became more acute.

An enormous amount of study has gone into the selection of appropriate lining material. In addition to possessing an adequate corrosion resistance, there were mechanical requirements of strength, weldability, favorable thermal expansion characteristics, etc.

It was recognized that only tests of materials under operating conditions would serve to select the suitable ones. Many such tests were made. When the equipment is operated at temperatures above the condensation temperature of water, the problem of testing is fairly simple. In locations where water exists the problem is complicated by the need to insulate the specimens from one another and from steel equipment. The insulation is necessary to avoid forming couples in which the less noble material would show a higher rate of corrosion than normal for the location and the more noble metal would show less than normal corrosion.

It is not generally recognized that in a refinery there are more needs for protection in low temperature areas, i.e., where water can exist, than in the hot, dry areas. The requirements in low temperature areas are also more diverse.

The test spool (Fig. 5) has been used extensively to study corrosion in various parts of refineries. Where no water condensation takes place the insulators have been omitted by the laboratory of a leading oil company that uses this type of spool.

From the various studies made, it is evident that stainless steels, i.e., those high in chromium, are required where sulphur is the attacking reagent at elevated temperatures, but that other and often non-ferrous materials are needed where electrolytic corrosion can take place. A tower such as shown in Fig. 6 indicates an intelligent use of this information.

Electrolytic corrosion is a widespread scourge of refinery equipment. The mechanism of this type of corrosion can be shown by placing a nail in a salt solution containing two indicators and agar to jell the solution. Hydrogen ions can appear in red and metal ions in blue.

● **General.** To indicate the importance of the preliminary tests a requirement arose for a material to resist a fraction from a crude containing sulphur and also naphthenic acids. A natural selection might indicate stainless steel. The preliminary spool tests showed conclusively that the normal stainless grades were destroyed at a rate higher than for carbon steel. From the tests it developed that a molybdenum variety of the 18 chrome-8 nickel steel or a high nickel alloy, Inconel, approximately 80 nickel-13 chrome, would have to be used. As Inconel was available as seamless tubing, it was selected for the units.

Another interesting test that gave hindsight and future foresight occurred when some sulphuric acid became unaccountably corrosive. (Table 1.) Misreading some home-made tests, copper parts were put in a tower in the acid stream. The copper went into solution and changed the corrosive character of the stream to the extent that the spe-

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cial alloys, normally resistant to sulphuric acid, were destroyed. Tests made in the acid but under laboratory control indicated the cause of the intense corrosion; indicated a resistant alloy (high silicon cast-iron) and pointed to future avoidance of the trouble.

The demand of the war for high octane gasoline led to the use of several refining methods that introduced corrosives not previously encountered in refineries on a large scale. Reference is made to hydrofluoric and hydrochloric acids. Time did not permit a preliminary study, so the studies and plant corrosion proceeded apace. Through the beautiful cooperation existing on all hands, studies were rushed through that indicated Monel for use vs. hydrofluoric acid and Hastelloy B, an alloy of nickel and molybdenum, vs. hydrochloric acid. Nickel is becoming more widely used vs. hydrochloric acid due to a discovery made and retained by one of the major oil companies that permit its use. (Fig. 7 and 8).

TABLE 1

Effect of copper sulphide addition on corrosiveness of sulphuric acid.

Acid concentration	45% by wt.
Temperature	250°F.
Duration	6.5 days
Rotation speed	1725 r.p.m.
Aeration	none

Metals	Corrosion rates, m.d.d.* C. P. acid	C. P. acid 1.54 g.p.L. of $CuSO_4$
Hastelloy "B"	216	8,640
"S" Monel	296	3,280
Copper	6,550	.....
High silicon cast iron ("Corrosiron," "Duriron")	20	17.3

*m.d.d.—Milligrams per sq. decimeter per day.

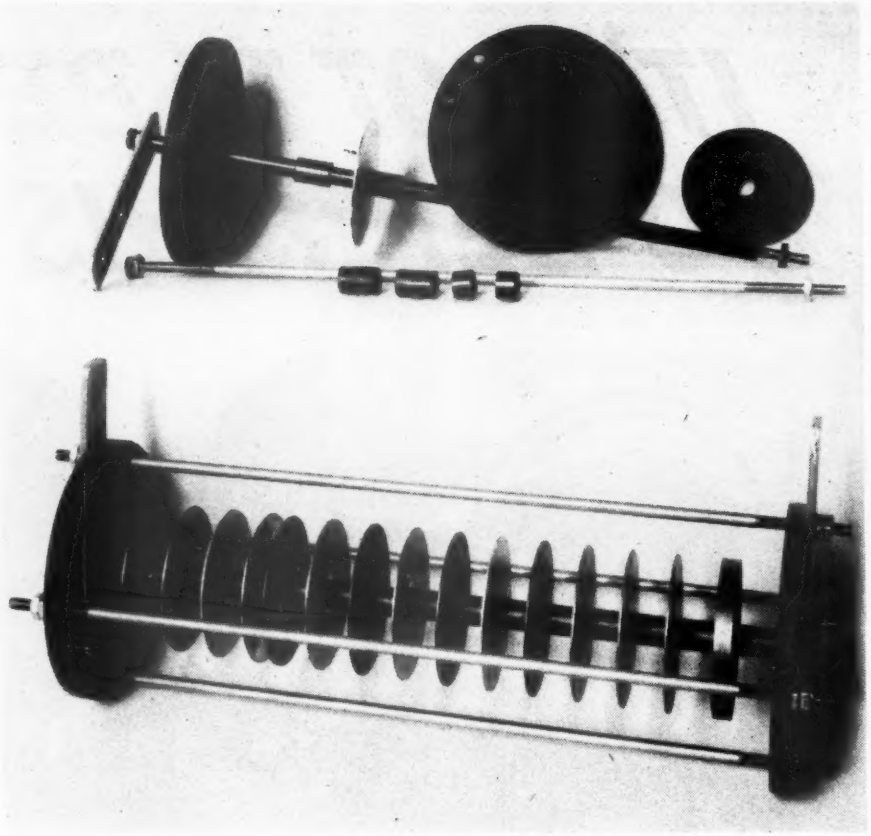

FIG. 5. Corrosion test spool.

One of the most interesting problems now under study is in connection with the corrosion from the co-called condensate wells. This corrosion is baffling in that it occurs under conditions difficult to predict and to reproduce. The corrosion is apparently associated with change in pressure levels, with presence of water and carbon dioxide and possibly with organic acids.

If there is merit in the suggestion that a solution can be obtained by application of manhours to a problem, this one is well on the way to solution. In addition to the effort put forth by the companies experiencing the corrosion, this problem engages the attention of groups from the NGAA, NACE, the API, and the Bureau of Mines. A fellowship at Battelle also studies phases of the problem. The work is proceeding in an orderly manner. Some primary efforts are being directed logically toward finding a specimen holder that will induce uniform corrosion of all specimens in the holder. When this is acomplished a number of alloys will be exposed and the problem will be well on its way to a metallurgi-

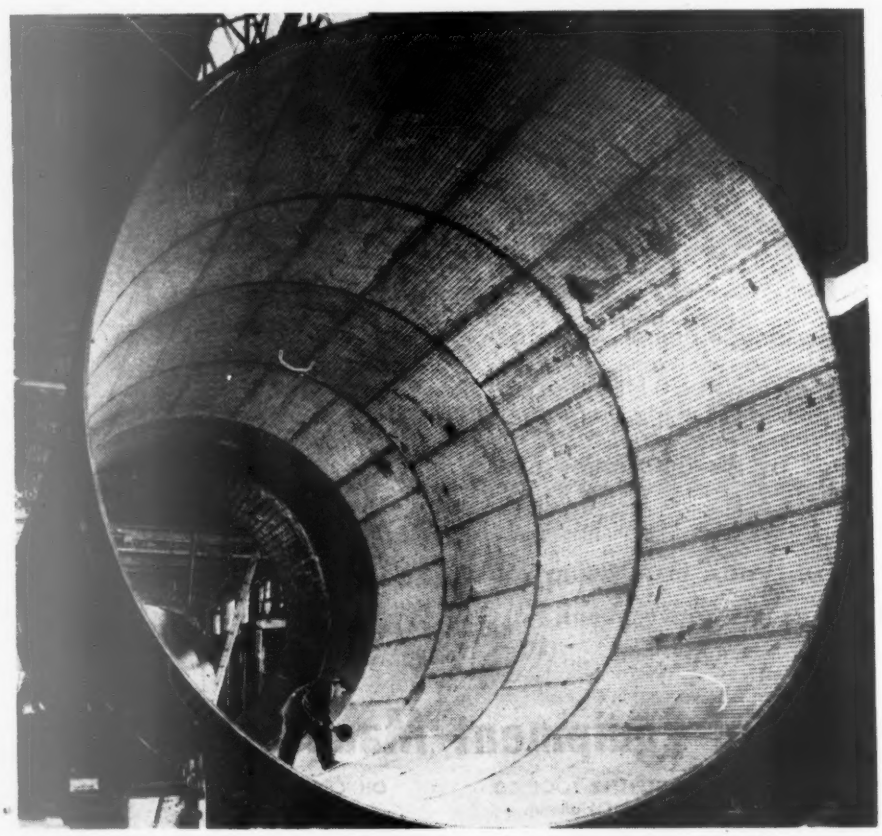

FIG. 6. Fractionating tower lined with 18-8 alloy over bottom section and Monel over top section to meet changing type of corrosion. —Tower by A. O. Smith.

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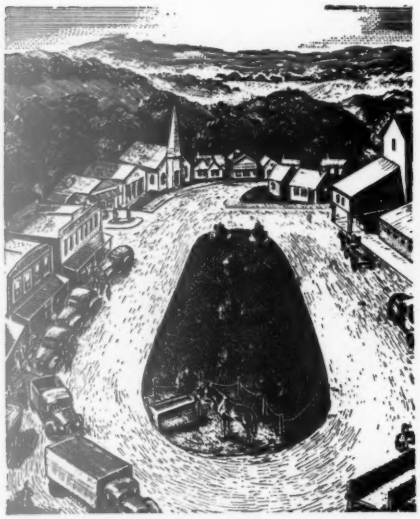

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VERTICAL TURBINE PUMPS

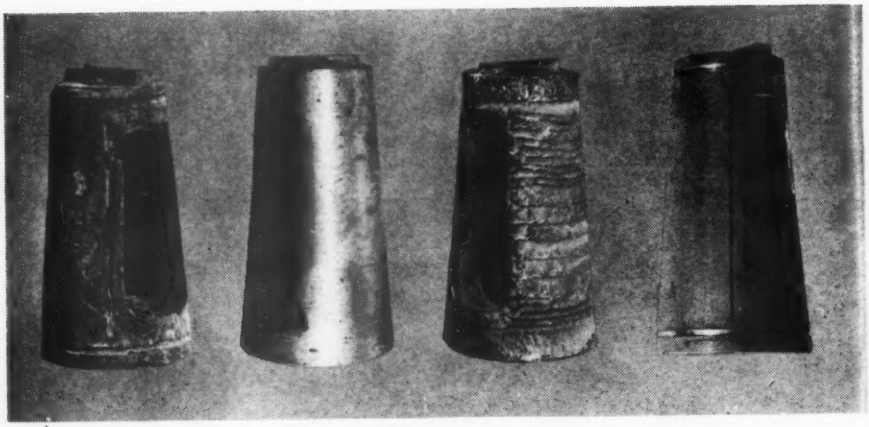
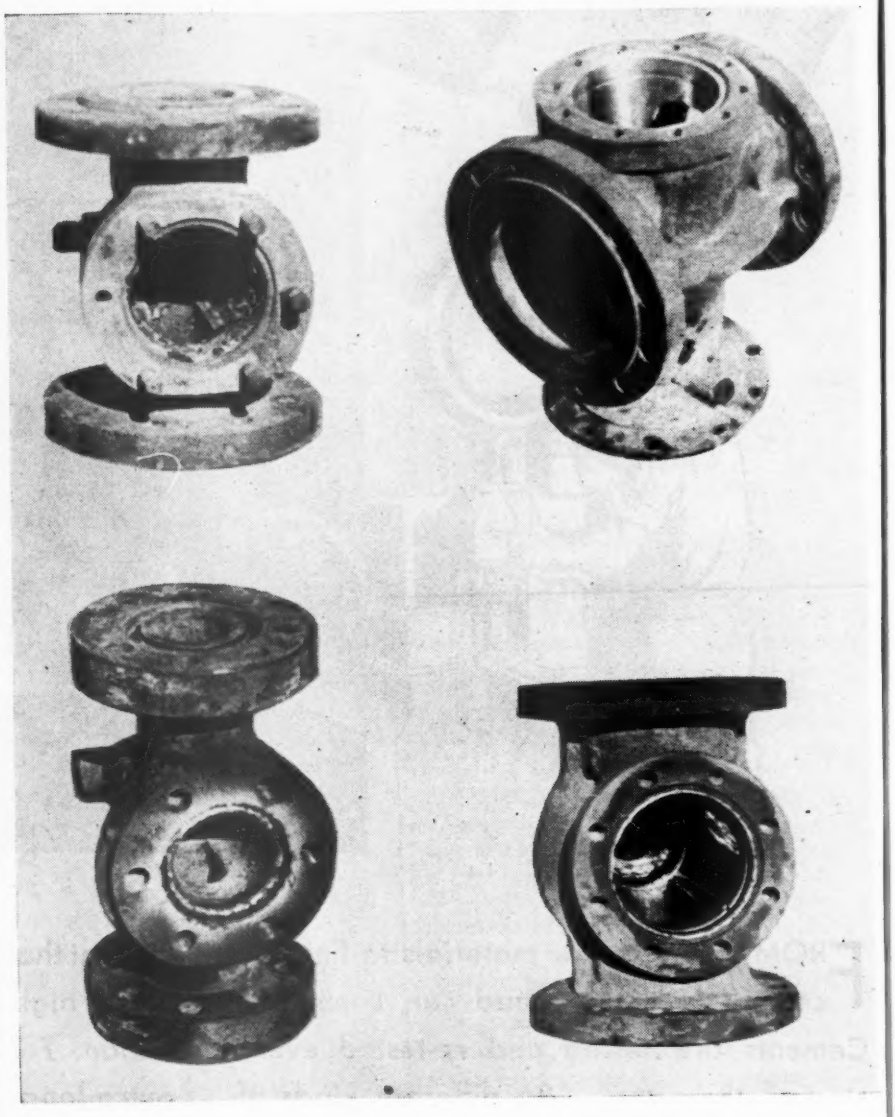


FIG. 7. Method of repairing plug of valve by Monel overlay.

FIG. 8. Valve bodies lined with Monel to resist HF acid.



cal solution. The chemist and others interested in the causes of the corrosion and the possible reagents contributing are reported to be making progress. It is not the place here to more than hint at their work.

● **Conclusion.** In this discussion an effort has been made to show that problems of the petroleum industry are amenable to solution by appropriate research and development work and that such work goes on constantly.

A curve indicative of progress in such development work is shown to indicate that evidence of progress occurs some time after a project is launched. This point is considered important to those who must show returns from expensive ventures. ★ ★ ★

SEABOARD EXPLORES LOS ANGELES CITY AREA

By **RICHARD SNEDDON,** *Pacific Coast Editor*

DRILLING ahead in hard shale at 6888 ft., Seaboard Oil Company of Delaware's well, L. A. Brick No. 1, in the Los Angeles city area near Elysian Park, is rapidly approaching that stage of development at which it must either produce or be abandoned. Nothing at the moment indicates a prospective producer, but, as indicated, the well is still drilling ahead and there is, thus, no necessity for jumping to hasty conclusions—the bit will soon tell the true story.

EXCLUSIVE

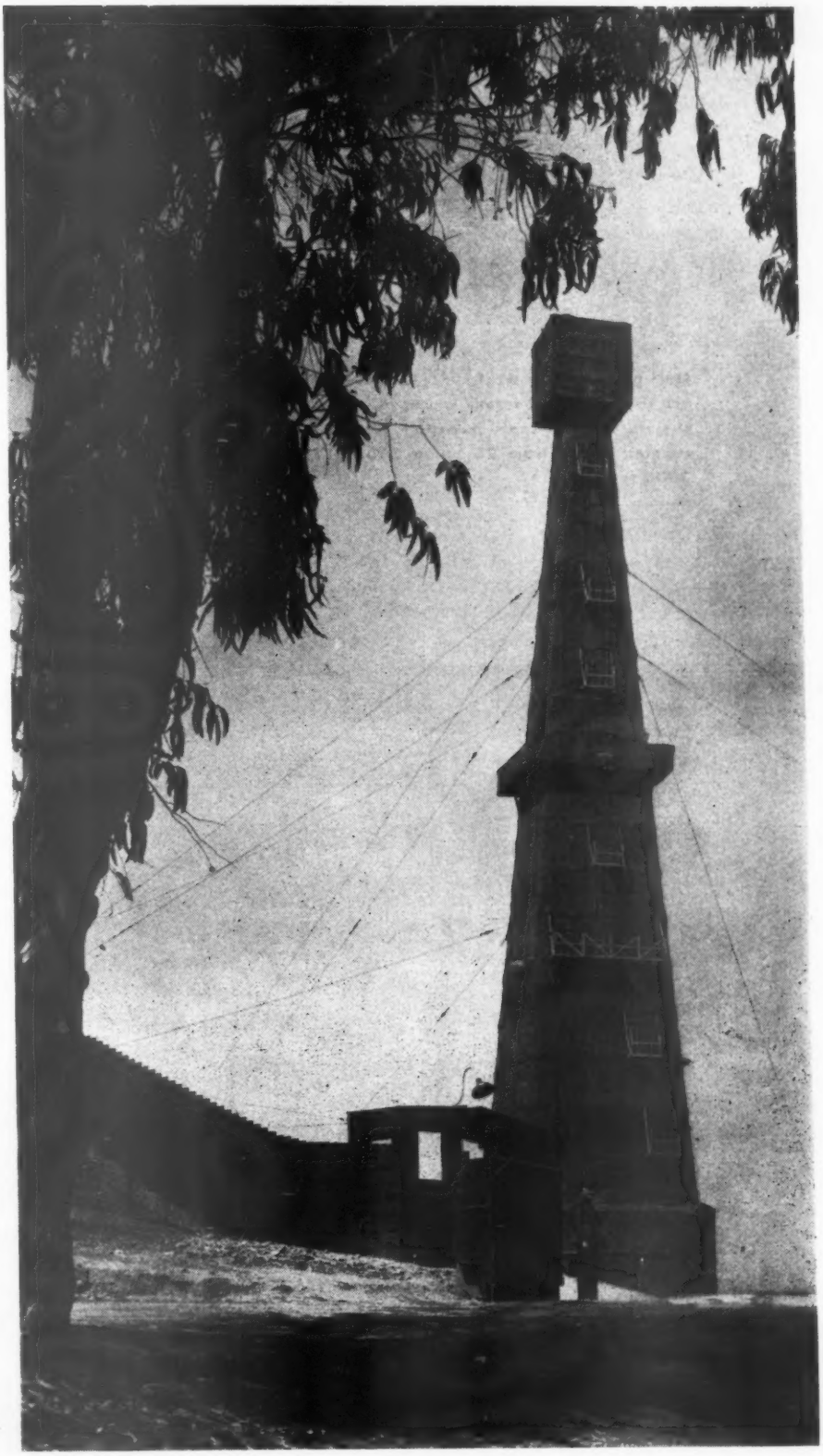
From many angles, however, the well is an interesting one regardless of its eventual outcome. Once before, about a year ago, indeed, Seaboard made an effort to tap the deep zone production that has been found in other adjacent fields but in the city area proper has so far remained undiscovered. The first test, Park No. 1, was located on the edge of Elysian Park, about a mile northeast of the present well, near the intersection of Riverside Drive and Landa Street. It created a great deal of excitement at the time it was drilled, but was a short lived venture. At a depth of 1300 ft. a quite unexpected basement was encountered and the well had to be abandoned.

Such exploratory wells, inside the city area, have to be drilled under very exacting conditions. Stipulations in the agreement with the city and general municipal requirements demand, for example, that every possible precaution be exercised. Thus, the derrick on the new well is covered with fire-resistant canvas quilting. A 136-ft. Emsco derrick with 8-ft. extended legs is employed, so it can be imagined that closing in the rig completely in this manner was something of a quilting bee. Made up in panels that can be quickly installed and with equal celerity removed, the quilting consists of a layer of fiberglas sandwiched between two layers of canvas. These are installed in such a manner that each one overlaps its neighbor and all of them are securely and safely anchored by a combination of metal hooks and ropes.

This housing-in provides an unusual measure of protection both on and off the rig. The spread of fire, either from the rig to the outside, or in the reverse direction, is adequately controlled. Damage to surrounding property by a possible blow-in is prevented. The working crews and equipment are sheltered from the elements and last, but by no means least, the citizens of Los Angeles living in nearby areas can sleep soundly, undisturbed by any of the usual drilling

(Continued on Page 150)

Fireproof, soundproof outfit on Brick well near Elysian Park.



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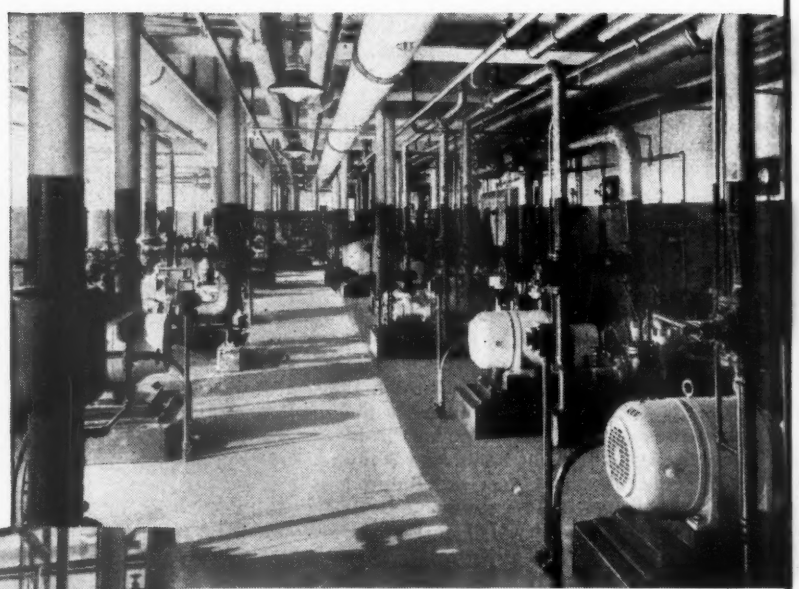
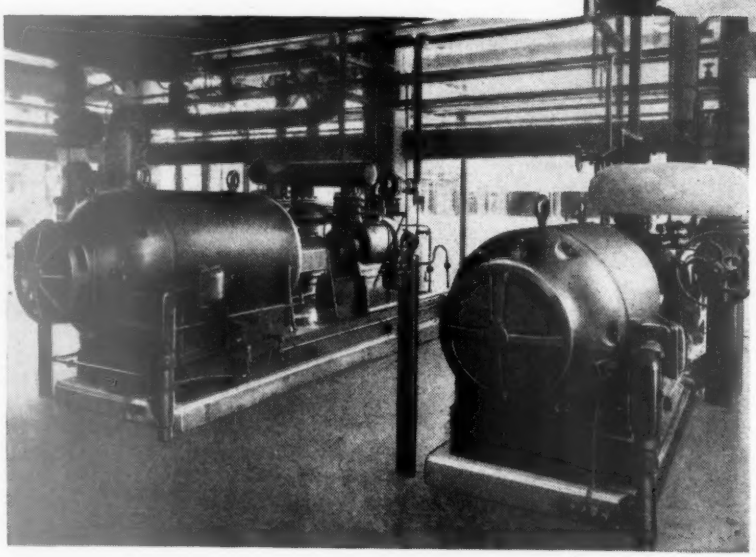
Main pump room in a refinery. The pumps are driven by G-E totally enclosed, fan-cooled, squirrel-cage induction motors ranging in size from 25 hp to 250 hp, 3000 rpm.





Tutwiler Refinery of the Cities Service Oil Company at Lake Charles, La.—Two large, totally enclosed, fan-cooled, explosion-proof, squirrel-cage induction motors, each coupled to a centrifugal pump. The motor at the left is a 600-hp, 3600-rpm Type K, and the one at the right is a 500-hp, 3600-rpm Type K-6339Z.

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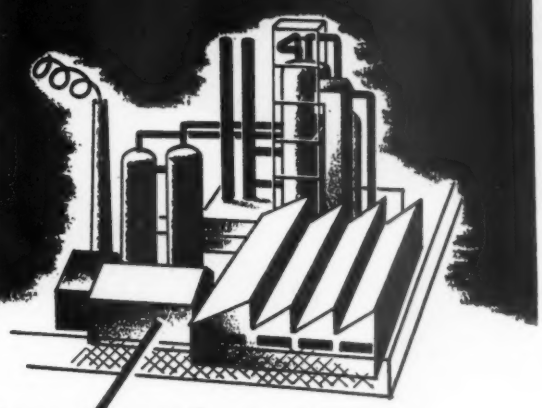

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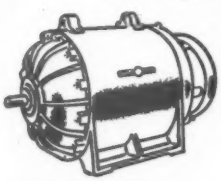
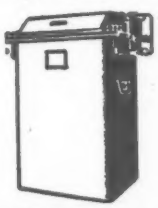
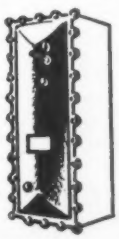


G-E Motors—Available types include squirrel-cage, wound-rotor gear-motors, brake-motors, and motor-generator sets in sizes ranging from fractional-hp to 1000 hp, 3600 rpm.

G-E Vertical Motors—Provide extra security in pumping liquids from underground tanks. Nonsparking ratchet prevents reverse rotation and damage to pump. Most types and ratings available in horizontal explosion-proof motors can be had in vertical motors.



G-E Air-break Starter—This combination starter is available in magnetic or manual types for full- or reduced-voltage starting, from 1 to 100 hp.



G-E Oil-immersed Starter—This highly protected unit may be had in ratings from 5 to 3500 hp for full- or reduced-voltage starting.

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Long before World War II, the Harrisburg Steel Corporation enjoyed a world-wide reputation as one of the few pioneers in the manufacture of Seamless Steel Products. Its Seamless and Drop-Forged Steel Plant occupies many acres and is contributing very substantially to the war effort.

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**The illustration above is a reproduction of the History of the Harrisburg Steel Corporation. A limited number of these copies is available for distribution to the general public.*

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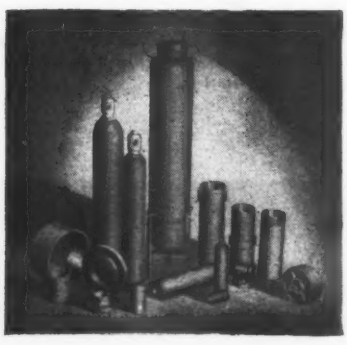


(Continued from Page 147)

noises. This latter is further assured by the fact that electricity is used as the power source. It is supplied, incidentally, by the Los Angeles Bureau of Power and Light, from its 34,500-volt transmission line.

The ordinance governing drilling within the city limits forbids that any hydrocarbon gases be vented to the atmosphere and it is further required in the event of a successful completion that all flow manifolds, pumping equipment, piping, etc., be kept below the level of the ground, and insofar as possible be removed from the public gaze. The use of sumps and pits is also forbidden and it therefore becomes necessary to substitute steel tankage.

The City of Los Angeles has always been reluctant to permit drilling in the metropolitan areas, but actuated by the increasing war demands and the critical status of the oil discovery program, finally zoned the park for drilling. For the convenience and safety of residents in the neighborhood, however, a number of restrictions were imposed that would not be required in a suburban operation. In compliance with these regulations the project in its entirety is hidden from the view of people on the ground level by a high and continuous board fence, which is painted olive green so that it will not clash too outrageously with the surrounding scenery.

The equipment used on the Seaboard well includes Ideal drawworks, Regan traveling blocks, Super-speed rotary table, Hydril drill pipe, gas protected motors by General Motors and Westinghouse, Wilson-Snyder and Emsco pumps and an Overstrom shale shaker. The rig is wired to provide outlets for portable welding machines, heaters, and any other electric appliances or devices that might be used. Remote controls, located conveniently and safely, are provided for the two hoisting motors and the additional two that operate the pumps. Communication between the driller, derrickman, and pump house, is carried on by means of a two-way vapor-proof speaker system.

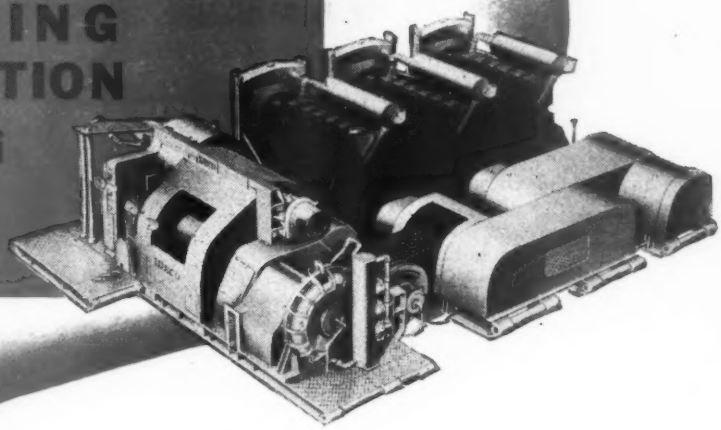
The location of the present well is not far from the spot where in 1898 a number of wells were drilled by the Capital Milling Company. These were shallow wells and most of them were completed as small producers. The field, as is well known, was originally discovered by E. L. Doheny and Charles Canfield. In its heyday it stretched from North Broadway to Vermont and boasted a considerable number of shallow wells producing up to 150 bbl. a day each.

In the meantime, the belief has persisted that deeper zones would one day be tapped in the city area, and Seaboard has already carried its L. A. Brick No. 1 far beyond any hitherto exploited depth in order to test this belief. Whether or not the well is completed as a producer, the project should decidedly expand the available data on sub-surface structure and at least aid in the evaluation of future prospects. ★ ★ ★

Everything

FOR DRILLING AND PRODUCTION

- - everywhere there's oil !



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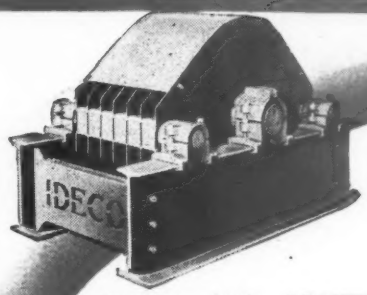

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GEARED PUMPERS—Complete range of sizes now available—proved in the field by years of constant service.

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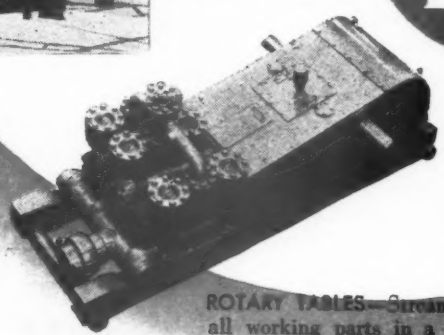
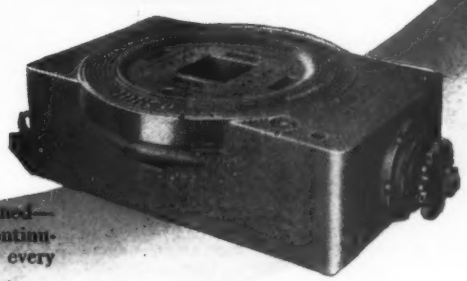


SLUSH PUMPS—Clark Triplex Steel Slush Pumps—another Dresser Industries product—supplement the drilling and production equipment supplied by IDECO.



ROTARY TABLES—Streamlined—all working parts in a continuous bath of oil. A size for every requirement.

BACK PRESSURE OPEN FLOW COMPUTATIONS SIMPLIFIED

W. F. MARTIN, Texoma Natural Gas Company

REGULATORY bodies governing the withdrawal of natural gas from the various gas fields have much detail with which to contend in connection with open flow. At present they must have an individual graph for each well from which to compute changes in open flow occurring because of changes in rock pressures. This means that voluminous files must be maintained in these offices.

EXCLUSIVE

Quite some time ago the writer devised a computing chart to arrive at changes in open flow caused by decline in rock pressure that might be used to eliminate much of the cumbersome detail. This chart was published in *The Petroleum Engineer's* Continuous Tables, in April, 1944, on page 193, under index number P 533.401.

In this discussion, certain terms will be used, the definitions of which are shown below:

P = gage pressure.

P_f = formation pressure, lb. per sq. in. abs.

P_s = back pressure on the sand, lb. per sq. in. abs.

P_2 = shut-in wellhead pressure in lb. per sq. in. abs.

n = curve slope.

GL = gravity × depth.

Q = volume of gas, cu. ft.

Letters are used for convenience to designate the scales. The definitions of these letters appear below:

A = wellhead pressure, gage, plus weight of static column of gas, or $P_f - 13$.

B = curve slope, or "n".

C = $(P_f^2 - P_s^2)^n$.

D = curve coefficient.

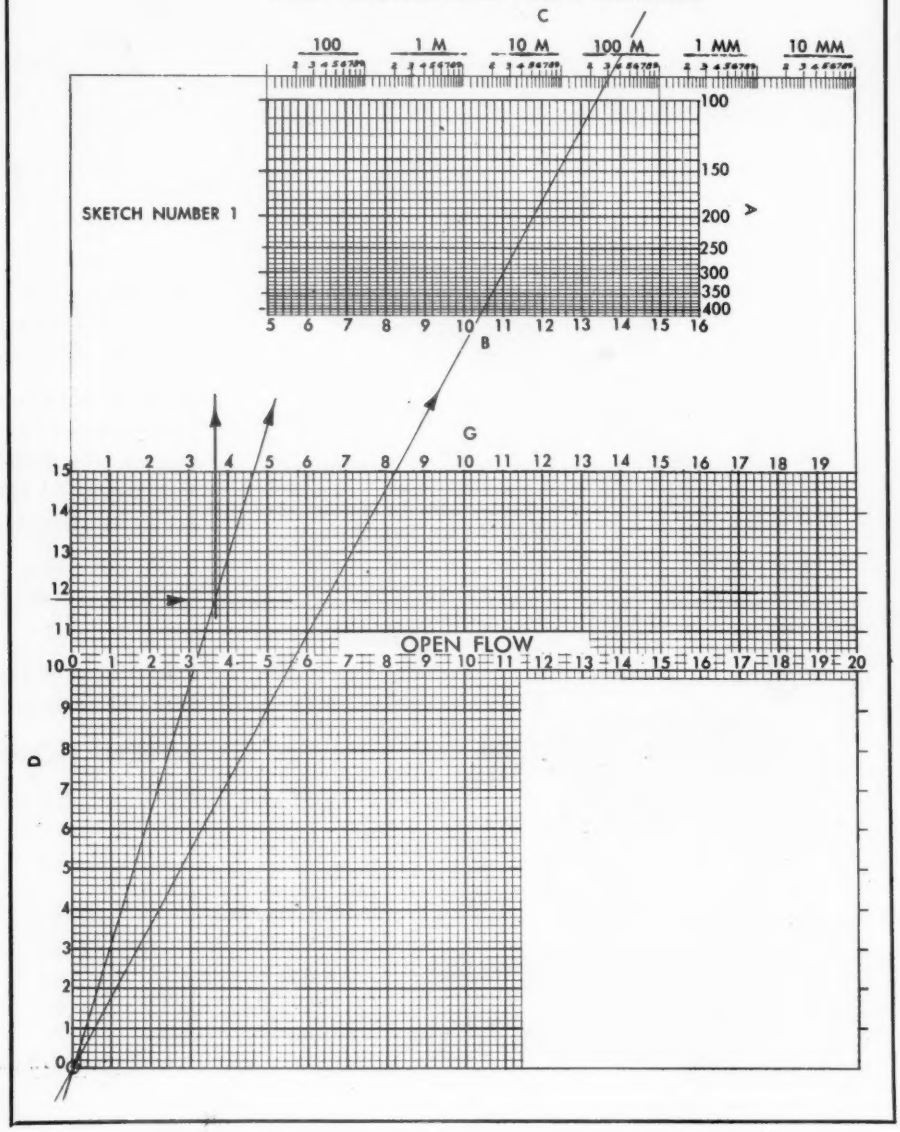
G = ("10" horizontal lines) n Log $(P_f^2 - P_s^2)$ and Q.

The chart is equipped with a transparent arm pivoted at chart zero. This arm has a center line drawn on it, and for purposes of convenience, this center line will be referred to as "L".

To use this chart effectively, certain data will have to be compiled. It is suggested that these data be compiled in the following form:

SKETCH NO. 1

BACK PRESSURE OPEN FLOW COMPUTER



1. test date	2 well name and number	3. rock press. gage	4. column weight	5. A 3 + 4	6. B n	7. D coef.	8. back pressure open flow M. cu. ft.
8-15-45	Smith No. 1	310	24	334	0.90	118.00	4,400
8-17-45	Jones No. 1	305	24	329	1.105	12.50	5,000

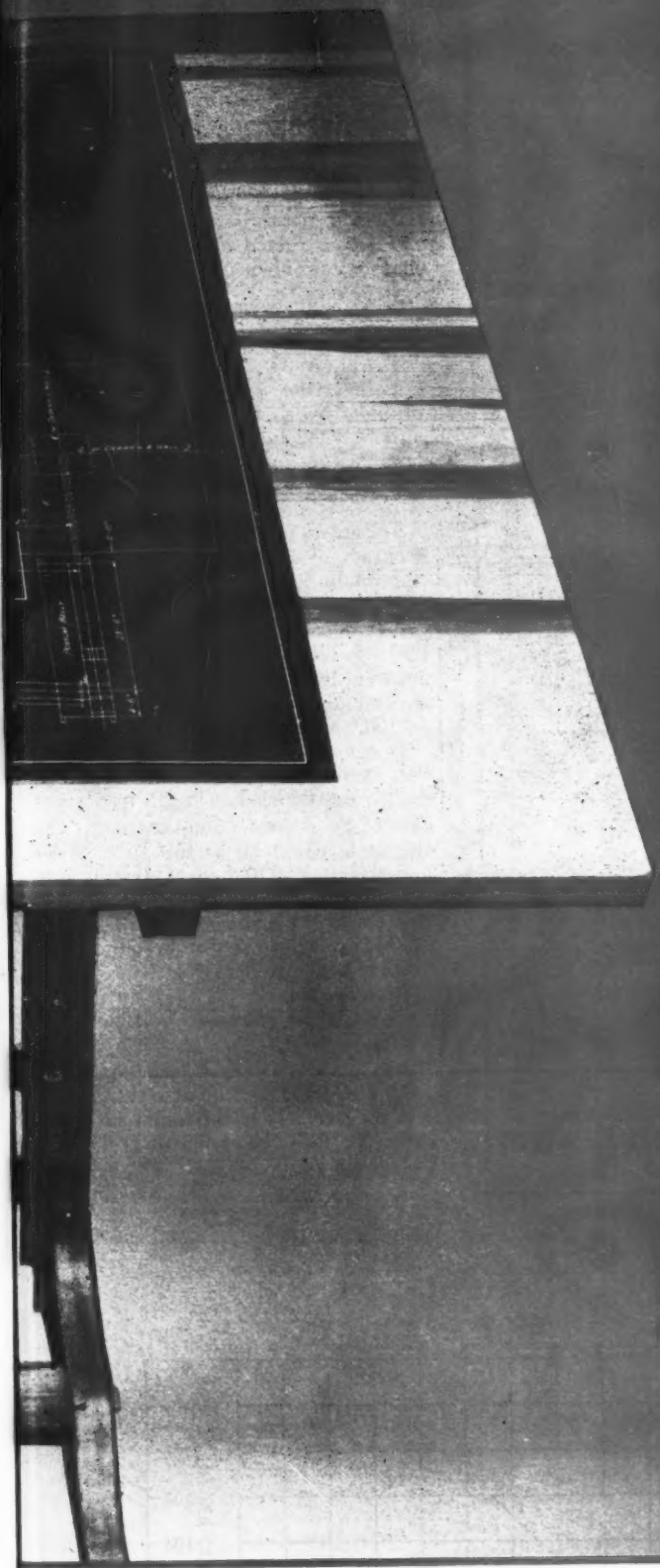
In the above the rock pressure, column weight, B and D are given. Column A is obtained by adding rock pressure and column weight. The open flow is then obtained from the chart.

Explanation of scales on the chart is as follows:

A—The points for this scale are 1/log $[(P+13)^2 - P_s^2]$. For instance 300 on this scale is 1/log $[(300+13)^2 - 13^2]$. The scale is designed for the use of gage pressure in the Texas Panhandle field; therefore, if P_f is used, 13 lb. must be deducted from it to obtain an A scale figure.

B—The points for this scale are regu-

(Continued on Page 156)



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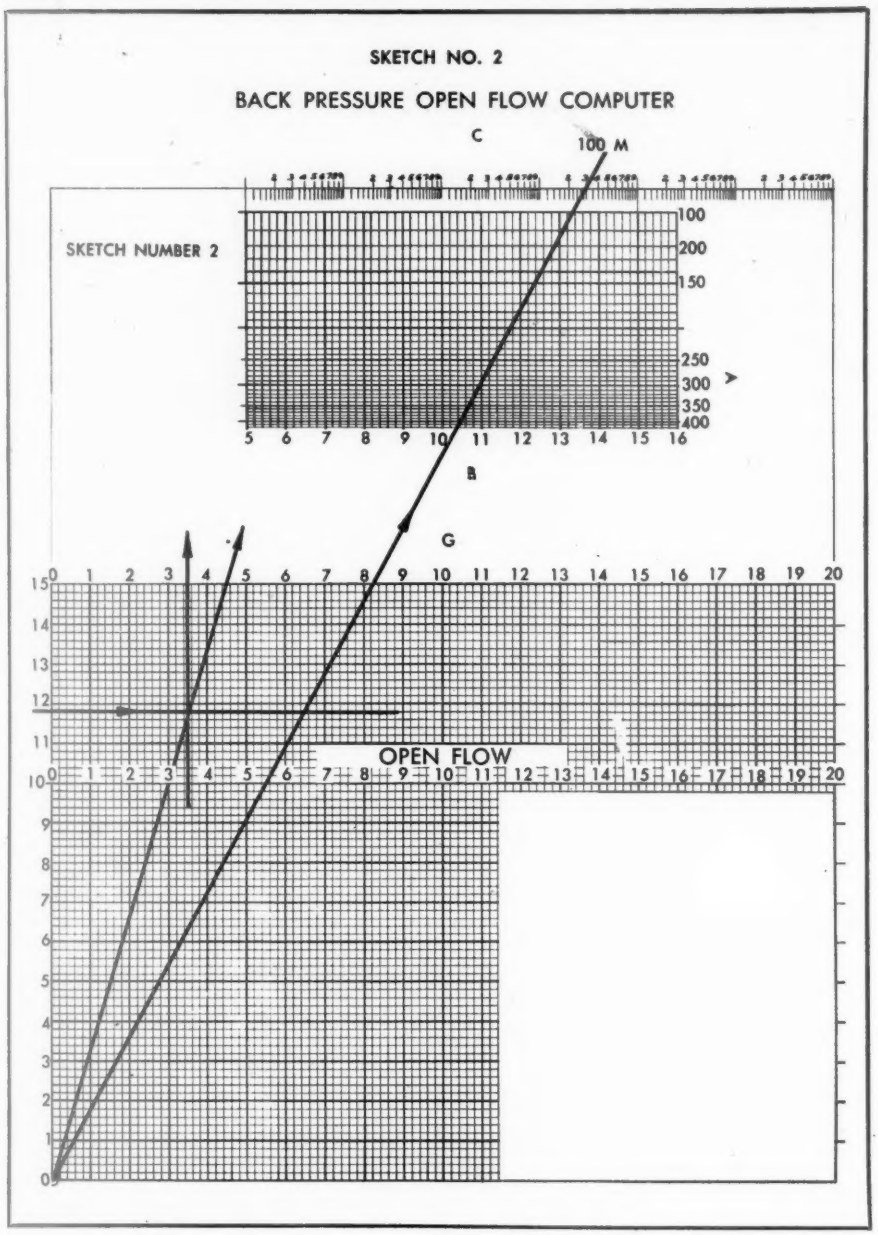


in itself indicates a $(P_f^2 - P_s^2)^n$ of hundreds of thousands. Hundreds of thousands are also indicated on the C scale.

It is quite possible that an A scale would be required where the figures would represent absolute pressures instead of gage pressures. The points for such a scale would be $1/\log (P_f^2 - P_s^2)$.

Sketch No. 2 shows a portion of the chart constructed on this basis, and illustrates problem No. 2.

Problem No. 2.

Given: A = 300 (P_f in this case); B = 1.105; C = 11.80.

Required: Q.

Follow the same procedure as in problem No. 1. It will be observed that, although the factors are practically the same as in problem No. 1, the Q is 3,540,000 cu. ft. In problem No. 1 the Q is 3,660,000 cu. ft.

These two problems also illustrate the accuracy of computations by this chart. The readings from the chart show a difference of 120,000 cu. ft., whereas the calculated difference, based on $(P_f^2 - P_s^2)^n$, is 118,000 cu. ft. A discrepancy of 2000 cu. ft. is negligible when open flow is commonly read to the nearest 10,000, or 100,000 cu. ft.

In connection with the latter construction, it would be well to have a scale for the various GL's, showing P_f in percentages of P_2 in connection therewith. This GL scale could be at the right of the lower section of the chart. In this position on the chart it would be a handy reference. A portion of this chart, with the GL scale, is shown herein in connection with problem No. 3.

Problem No. 3:

Given: $P_2 = 350$; GL = 2100.

Required: P_f.

Procedure: Observe percentage of 107.5 opposite GL 2100 at right of chart section. Place L at this point on the G scale. At the intersection of D 350 and L read 376 on the G scale. $P_f = 376$ lb.

★ ★ ★

(Continued from Page 152)

lar and coincide with the lower section of the chart.

C—This is an anti-log scale—a separate scale for each major section of lower section of the chart.

D and G—These are scales of regular divisions.

Operation: By placing L at an intersection of A and B we divide B by A. This division gives $(P_f^2 - P_s^2)^n$ on the C scale where L crosses it. On the "10" horizontal line of the G scale will be found n log $(P_f^2 - P_s^2)$. An illustration follows:

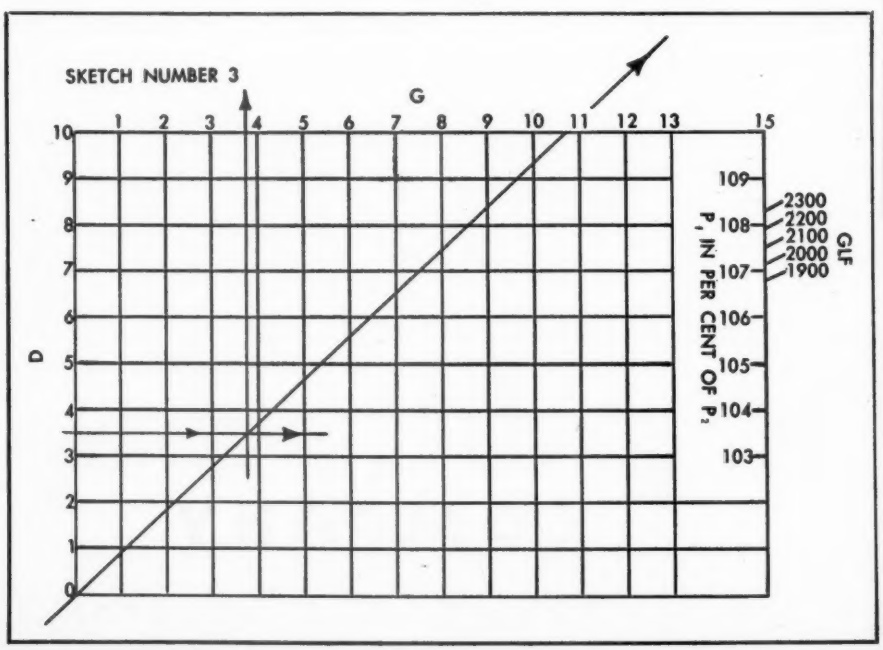
Problem No. 1—Sketch No. 1.

Given: A = 300; B = 1.1; C = 11.80.

Required: Q.

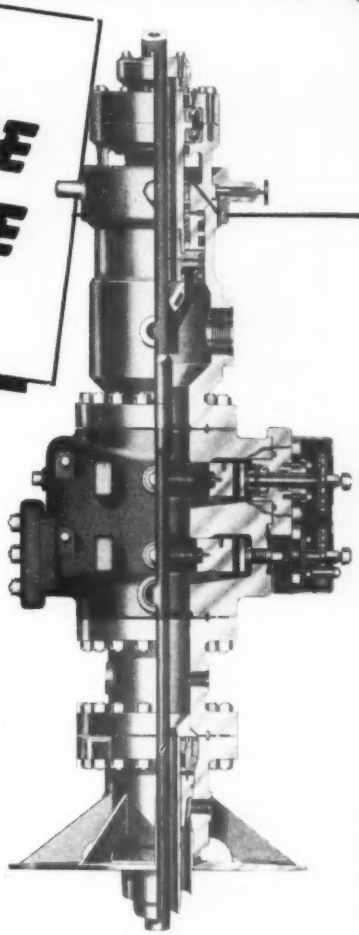
Procedure: Place L at intersection of A 300 and B 11, read C 310,000; move L to G 31, and at intersection of D 11.80 and L read Q = 3,660,000 cu. ft.

Note: It will be noted that L crosses the "10" horizontal line at slightly less than 5.50. This is n log $(P_f^2 - P_s^2)$. The log of 31 is 5.49+ and this figure



Another page of helpful information from Shaffer—headquarters for modern pressure control equipment.

When blowouts threaten YOU SIMPLY CLOSE THE SHAFFER GATE ...and it stays closed!



No auxiliary operations necessary! Both closing and opening actions are positive, fool-proof!

WHEN emergencies threaten, you want a control gate in your cellar that closes—and *stays* closed—without any auxiliary locking devices or extra operations to worry about. And you *get* this positive, fool-proof operation in Shaffer Control Gates because Shaffer rams operate by *positive* mechanical screw feed. They automatically stay in the position they are set *without any further safeguards on the part of the operator.* Therefore, only ONE quick operation is required to both close the Shaffer gate ... and *keep* it closed!

Think what this fool-proof feature means in protecting the safety of your well during the excitement and rush that accompany a threatening blowout. No auxiliary closing devices to operate—no risk of the gates opening under severest pressure conditions!

Yet, when it is desired to open Shaffer Gates, they open quickly and easily!

Six Other Shaffer Advantages

Rams that *automatically stay* in the position they are set without auxiliary devices are just one of the unique Shaffer advantages that have made these gates the outstanding choice for modern pressure control protection. Check these additional Shaffer features ...

1. **Cellar-Saving Compactness**—Minimum height reduces cellar requirements, saves rig-up time, cuts installation costs!

2. **Easy Ram Changes**—Rams can be completely changed in the Shaffer Gate by removing just ONE end cover!

3. **Simple Installation**—No complicated piping or space-wasting pressure manifolding is required for Shaffer Gates!

4. **Positive Mechanical Drive**—Ram operation is quick, simple, direct and foolproof.

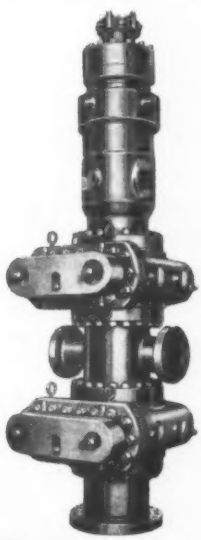
5. **Equalized Ram Pressures**—The higher the well pressure, the tighter Shaffer Rams seal off!

6. **Power Operation**—Choice of steam, electric and even hydraulic power drives are available for closing and opening Shaffer Gates.

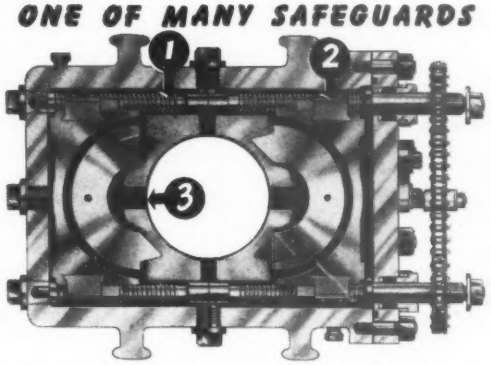
Shaffer Cellar Control Gates are available in a complete range of sizes from 6⅜" to 21½". There is a size to meet *your* requirements.

Get all the facts on Shaffer-engineered Control Gates by sending for your copy of the complete Shaffer catalog. Write today—or call at your nearest Shaffer representative.

The Shaffer Double Cellar Control Gate *(above)* and two Shaffer Type 38 Cellar Control Gates *(below)*—both hook-ups with Shaffer Combination Rotating Blow-out Preventer and Stripper on top



ONE OF MANY SAFEGUARDS



Positive, automatic closing is just one of many vital safeguards engineered into Shaffer Cellar Control Gates—safeguards that are vitally important when emergencies arise. ★ The screws that operate Shaffer rams are of non-corrosive stainless steel ... are a full 2" in diameter for powerful leverage and resistance to shearing stresses ... and they rotate in friction-free bearings that assure smooth effortless operation under even the highest well pressures. ★ The nuts and screws are *self-cleaning*—the half nuts acting as dies to keep the screw threads scraped clean. This unique self-cleaning feature is of great importance where the gates are operated in heavy mud. ★ The body of the gate is channeled and tapered toward the bore so that all sand, mud and cuttings wash back into the well, and the rams travel on guide surfaces that remain clean and mud-free. These and still other Shaffer features insure that the rams close easily—and *stay* closed—when blowouts threaten the safety of your well.

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Taking a bottom hole pressure test in the discovery well, Murphy-Sun No. 1 J. E. Holt. Difficult roads make it impractical to get test car to location, so a wagon is used to transport equipment.

DEVELOPMENT OF *Delhi Oil Field*

A. S. RHEA, Superintendent, Sun Oil Company

EXCLUSIVE

THE Delhi oilfield was discovered in December, 1944. The field as now known is situated in Richland Parish, Louisiana, in Township 17 North and Ranges 8 and 9 East, about 3 miles southwest of the town of Delhi and 2 miles south of U. S. Highway 80.

The discovery well, was drilled jointly by C. H. Murphy Jr. of El Dorado, Arkansas, and Sun Oil Company on the J. E. Holt Lease in the center of NW/4 of SE/4 of Section 21, T17N.R.9E. Drilling began October 31, 1944, and after much coring and testing the well was completed December 9, 1944.

The surface pipe was 10¾-in. SS casing weighing 32.75 lb. per ft. and was set at 539 ft., using 400 sacks of cement. The surface hole was drilled with one 12¼-in. fishtail bit with 15-in. reamers, which required 17½ hr. to drill to 546 ft.

Drilling below the surface pipe began November 4 with a 9⅞-in. fishtail bit and this size hole was drilled to 3152 ft., at which depth coring was begun. The drilling of the 9⅞-in. hole from 546 ft. to 3152 ft. required 2 fishtail bits, 1 drag bit, and 3 rock bits. The Holt No. 1 was cored from 3152 to 3425 ft. using wire line coring equipment. The size of the core hole was 8¾ in., and 3 hard formation core bits were used in the coring. The oil producing sand was found on November 14, 1944, at 3273 ft. Fourteen feet of saturated oil sand was found to a depth of 3287 ft. A drillstem test was made on November 20, 1944, with tool set at 3271 ft., total depth 3287 ft., ¼-in. chokes top and bottom. The tool was open 11 min. and the surface pressure increased to 150 lb. The recovery was 2000 ft. of clean oil, no water, with bottom hole flowing pressure of 1495 lb. per sq. in. gage.

The well was cored to a total depth of 3425 ft. but no additional oil sands were found below 3291 ft. A total of 18 ft. of saturated oil sand was found. The oil string was 5½-in. O.D. 14-lb. seamless casing set at 3367 ft. using 600 sacks of cement. For completion, the 5½-in. casing was perforated from 3280 to 3290 ft. with 22 holes ½-in. in diameter. The tubing run was 2½-in. with a 2½ by 5½-in. packer set at 3229 ft. The tubing perforations were from 3292-3303 ft. and the well was brought in by swabbing. The initial test, as gaged by the Louisiana Conservation Department, on December 13, 1944, through a ¼-in. choke was 505 bbl. per 24-hr. day of 41.7-deg. API gravity oil with tubing pressure of 625 lb. per sq. in. and gas-oil ratio of 530 cu. ft. per barrel of oil.

First important oil field in northeast Louisiana is being drilled on a regular 40-acre spacing plan.

The Holt No. 1 was drilled below the surface casing with mud of average weight of 9.5 lb. per gal. The weight was gradually increased to 10.0 lb. per gal. at the coring depth of 3152 ft. During the process of coring, a mud weight of 10.3 to 10.5 lb. per gal. was maintained. The bottom hole pressure in the oil sand was 1548 lb. per sq. in. gage, hence the calculated mud pressure of approximately 1750 lb. per sq. in. gage based on mud weight of 10.4 lb. per gal. gave a safety factor of 200 lb.

The drilling rig used to drill the J. E. Holt No. 1 was powered by two gasoline engines unitized with the drawworks

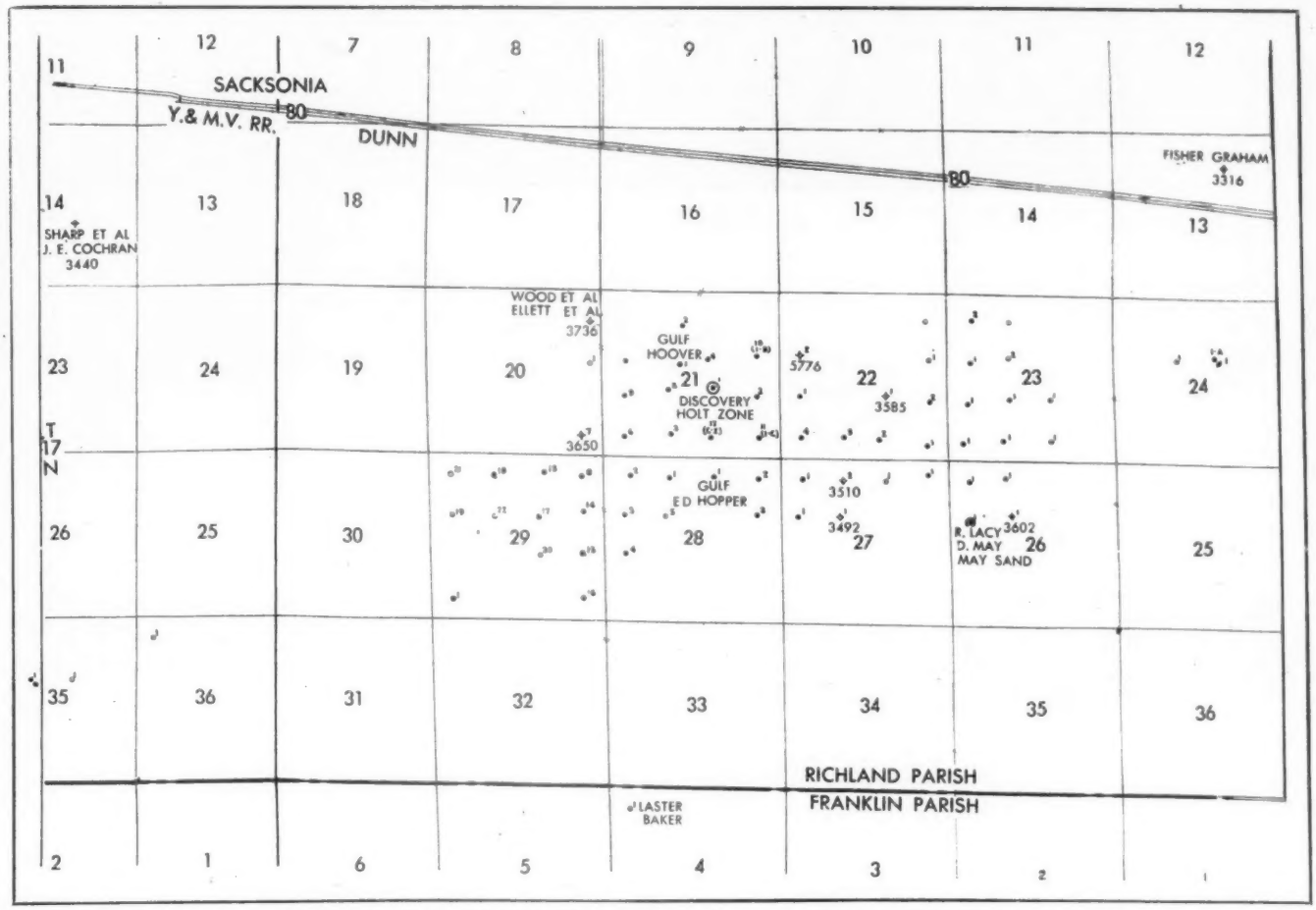


FIG. 1. DELHI FIELD, NORTHEAST LOUISIANA TOWNSHIP 17 NORTH AND RANGES 8 AND 9 EAST.

and a 7¼ by 14 in. slush pump. The drill pipe was 4½-in. 16.6-lb. O.D. pipe. The average weight on the bit while drilling or coring was 3 points.

The Delhi field has been orderly developed on 40-acre spacing. At the start, drilling was done outwardly from the discovery well, and at this time production extends about 1½ miles east and the same distance southwest of the discovery well, the average width of the field being 1 mile. In recent weeks oil production was found 4½ miles southwest of the discovery well by R. Caroway on the Bryant lease, which extended the field about 3 miles southwest. Oil saturated sand was also found in a well about 1 mile south of the town of Delhi and may extend the field 1½ miles eastward. These recent extensions give the field a length of almost 8 miles, but the width appears to be confined to 2 miles or less. To date 8 dry holes have been drilled in the Delhi field; 6 additional dry holes have been drilled within 5 miles of the field. (See Fig. 1.)

At present about 15 drilling rigs are operating in the field, all of which, except for two small steam rigs, are power rigs. The average time required to drill a well is 18 days due to the coring and drillstem testing done in the majority of wells. Since drilling the discovery well it has been the practice in most drilling operations to use mud of 11 lb. per gal. below the Clayton Chalk, a weight that affords ample protection and safety factor in the oil and gas zone and eliminates a hazard in the use of inexperienced crews.

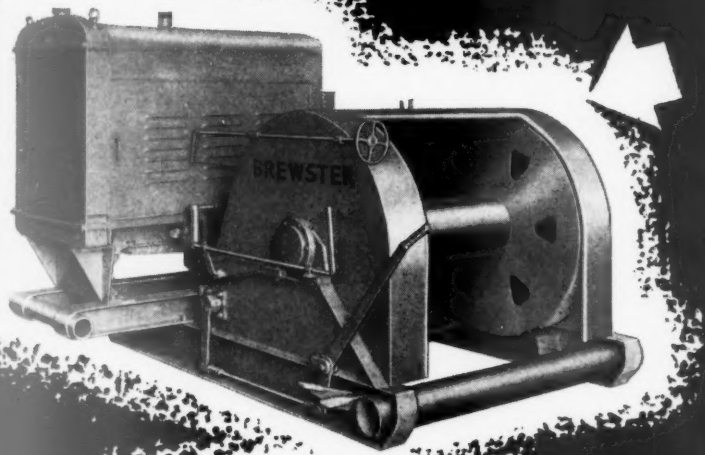
A typical electrical log of the producing section of a well is shown in Fig. 2. There are two recognized producing reservoirs, the Holt and the May. The Murphy-Sun J. E. Holt No. 1 discovery well is producing from the so-called Holt reservoir, which is divided into the Barrier and Holt sands. The May reservoir was discovered in the Lacy-D. May No. 1 about 1½ miles southeast of the Holt discovery well. Some wells in the field are so located that they can be produced from either reservoir. In the Holt zone the gas-oil contact is established at 3130 ft. subsea and the oil-water contact at 3286 ft. subsea.

Initial production tests on all completed wells are witnessed by a representative of the conservation department before allowable is assigned the well. The period of test varies from 2 to 6 hr. and the 24-hr. production is calculated on basis of test. The average daily rate through a 3/16-in. positive choke varies from 166 bbl. a day from wells in the May sand to 306 bbl. a day from the Holt sand. The gas-oil ratio for most of the wells varies from 275 to 600 cu. ft. per bbl. of oil and is solution gas. Only one well in the field has a gas-oil ratio in excess of 1000 cu. ft. per bbl. of oil as allowed by the Louisiana Conservation Department.

At the present time there are 42 producing wells in the field. Very little water has been produced to date and only 4 wells in the field are showing water. The oil emulsion is easy to treat and it has been found that heat of about 130° F. is the main factor in treating.

The oil produced is high in paraffin content and the wells show a rather fast rate of paraffin accumulation in the tubing. So far the most practical method of removing the paraffin from the tubing has been a mechanical scraper. High rates of flow tend to retard the rate of paraffin accumulation; however, this cannot be resorted to indiscriminately without injury to the wells.

The present well allowable is 109 bbl. a day for either the May or Holt reservoirs. For a short time wells in the Holt reservoir were allowed 120 bbl. a day and wells in the May reservoir 109 bbl. a day. The J. E. Holt No. 1 discovery well has produced approximately 34,000 bbl. of oil since completion on December 9, 1944, to October 1, 1945. The original bottom hole pressure in the J. E. Holt No. 1 was 1548 lb. per sq. in. gage at subsea of 3193 ft. There has been no



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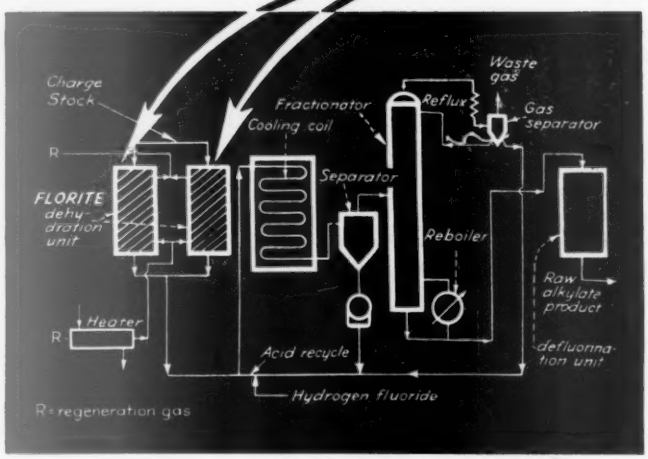

Industrial Advances call for More Efficient Drying Agents

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FIG. 2. ELECTRIC LOG.

Location of well	
NE ¼ of SW ¼ Section—23-17N-9E County—Richmond Field or survey—Delhi D.B. 100.5 Elevation—D. F. ..... or G. L.	Company—Murphy-Sun Well—Mayes No. 1 Run No.—1 Field—Delhi Survey—Sec. 23-17N-9E County—Richland State—Louisiana Filing No.—L173

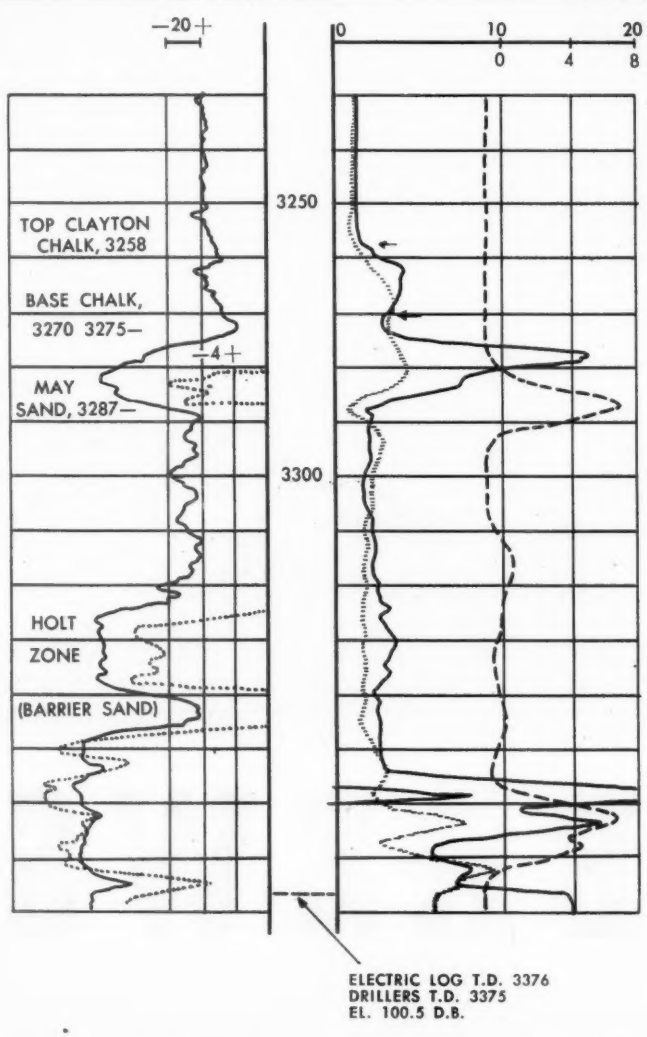
First reading	3376 ft.
Last reading	492 ft.
Footage measured	2884 ft.
Casing shoe depth:	
Electric log	492 ft.
Driller	492 ft.
Maximum depth reached	3376 ft.
Bottom depth: driller	3375 ft.

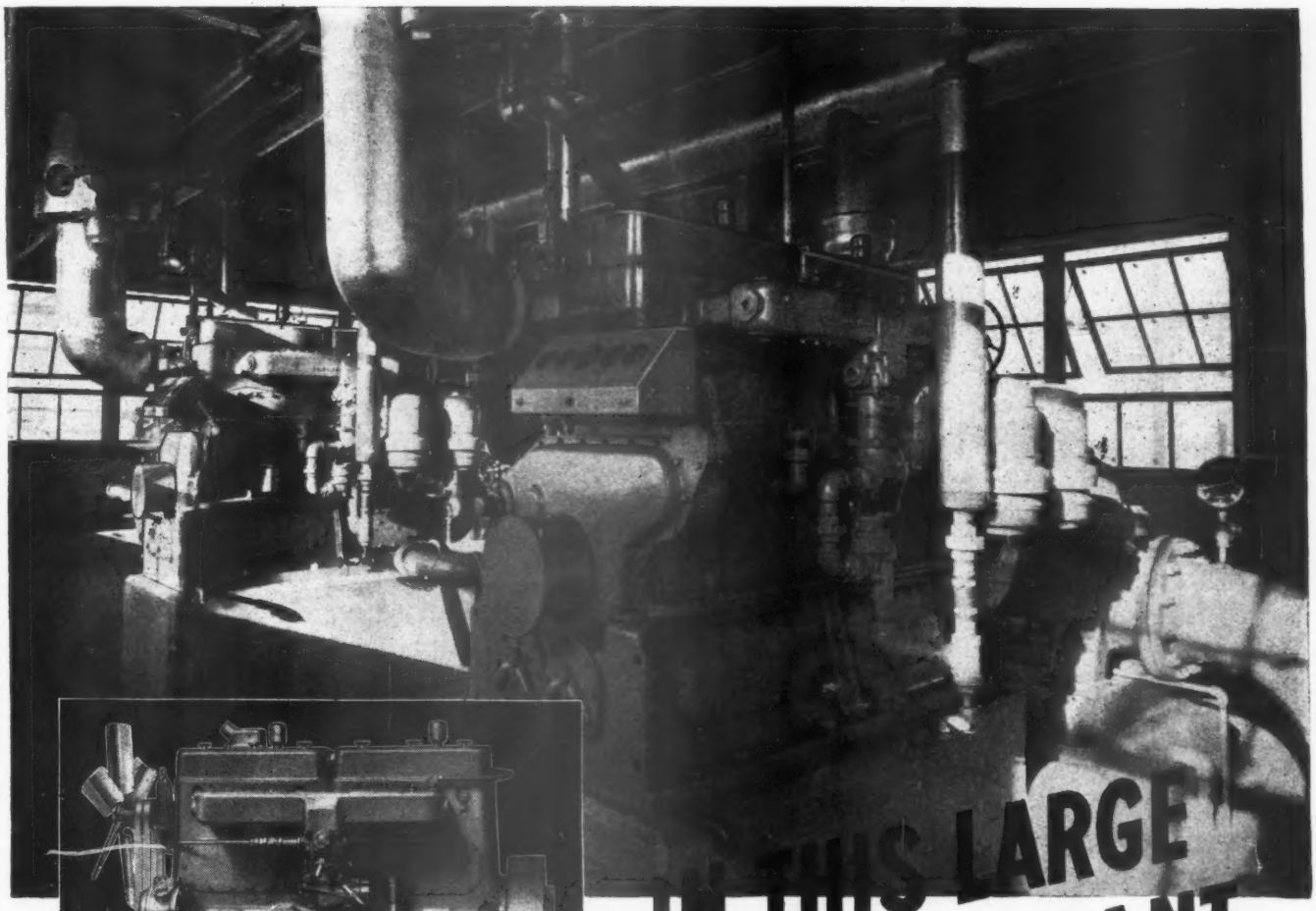
Depth datum—drive bushing

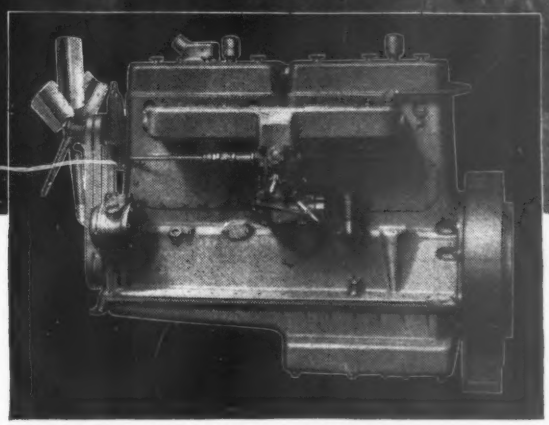
Diameter of hole	Mud characteristics	Spacings
From casing to bottom—8¾ in.	Nature—Chemical Weight—10.9 Viscosity—47	A M—16 in. A M—63 in.
Bottom temperature —135°F.	Resistivity—1.4 at 80°F.	O A—24 ft.

Remarks

Date—September 1, 1945 Observer—J. R. Bailey







MODEL 6-WAK WAUKESHA ENGINE. Burns gas or gasoline. Six cylinders, 6¼ in. bore x 6½ in. stroke, 1197 cu. in. displacement. Rugged . . to the last fine detail . . . from oil pan to head. Maintenance is easy and economical.

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● Installed by the Petroleum Equipment Co. of Los Angeles . . . twelve Super Duty Six Waukesha Engines . . . in two pump houses . . . circulate the process water used for cooling throughout this large cycling plant in California. It is one of the first plants of this kind in that area.

These Waukesha Super Duty Sixes are natural gas burning Model 6-WAK engines—direct connected to Ingersoll-Rand Cameron 10-ALV pumps, running 950 r.p.m. 17″ vacuum, used to circulate water through engine and compressor jackets. Built to deliver maximum power, on either gas or gasoline, this is *the* engine for oil industry pumps, generators, oil field and mobile heavy-duty equipment. *Get Bulletin* 1138.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS. • NEW YORK, TULSA, LOS ANGELES

Left to right, F. L. Stovall, representative of Louisiana Conservation Department, and George F. Carson, foreman for Sun Oil Company, at the Murphy-Sun No. 2 J. E. Holt, in the Delhi field.

noticeable change in producing characteristics and the pressure decline had been 24 lb. per sq. in. up to August, 1945, during which time 27,000 bbl. of oil had been produced.

The total production from the Delhi field up to October 1, 1945, is approximately 425,000 bbl. of oil. The average reservoir pressure decline has been of the order of 25 lb. per sq. in. It is too early to predict the type of reservoir drive, but it appears to be a water drive. There has been no indication of an increase in gas-oil ratio.

All the oil produced in the Delhi field is gathered by Murphy-Sun. About the middle of December, 1944, a 4-in. line was laid from the lease stock tanks near the discovery well to a loading rack about 1½ miles distant built on the Illinois Central Railroad. Oil was moved from the field by tank car shipment up to about September 1, 1945, at which time a 6-in. oil line was completed from the Delhi field to the Mississippi River, north of Vicksburg, Mississippi. Oil is now being moved through the new line to the Mississippi River and shipped from there by barge. Storage tanks are being erected near the Delhi field and at the loading dock.

Special field rules for the Delhi field have been prepared by the Louisiana Conservation Department in its Order No. 96 after a hearing held March 19, at Baton Rouge. The field spacing for both the Holt zone and the May sand is 40-acre units. The daily allowable is based on acreage. A gas-oil ratio limit of 1000 cu. ft. of gas per bbl. of oil has been established and wells with higher gas-oil ratio are penalized accordingly. A well potential and gas-oil ratio test must be taken within 5 days after completion. Monthly production tests and gas-oil ratio tests are reported to the conservation department. Static bottom hole pressure tests are made quarterly; also flowing bottom hole pressures at three rates of flow are to be made once a year.

The posted price of the Delhi crude oil is $1.18 a bbl. There are no producing gas wells in the Delhi field, the known gas zone being gas caps of oil reservoirs. Some of the power rigs in the field are run on gas produced with the oil and the remaining gas vented to the air. The gasoline content of the gas from the separators will average about 2.0 gal. per M. cu. ft. of gas. A casinghead gasoline plant can be expected to be installed after the field's extent is known. The total cost of a well when turned into the stock tank is approximately $25,000. Each well has been provided with a separate flow line, but as many wells on the same lease as is convenient and practical are produced into common lease storage.

Transportation was very difficult during the early development period because of lack of roads and excessive rain and it was necessary to resort to the use of board roads. The transportation alone has been a very expensive part of the operation and development. During the past several months graded roads have been built through the field and the main traveled roads are being graveled for all-weather transportation.

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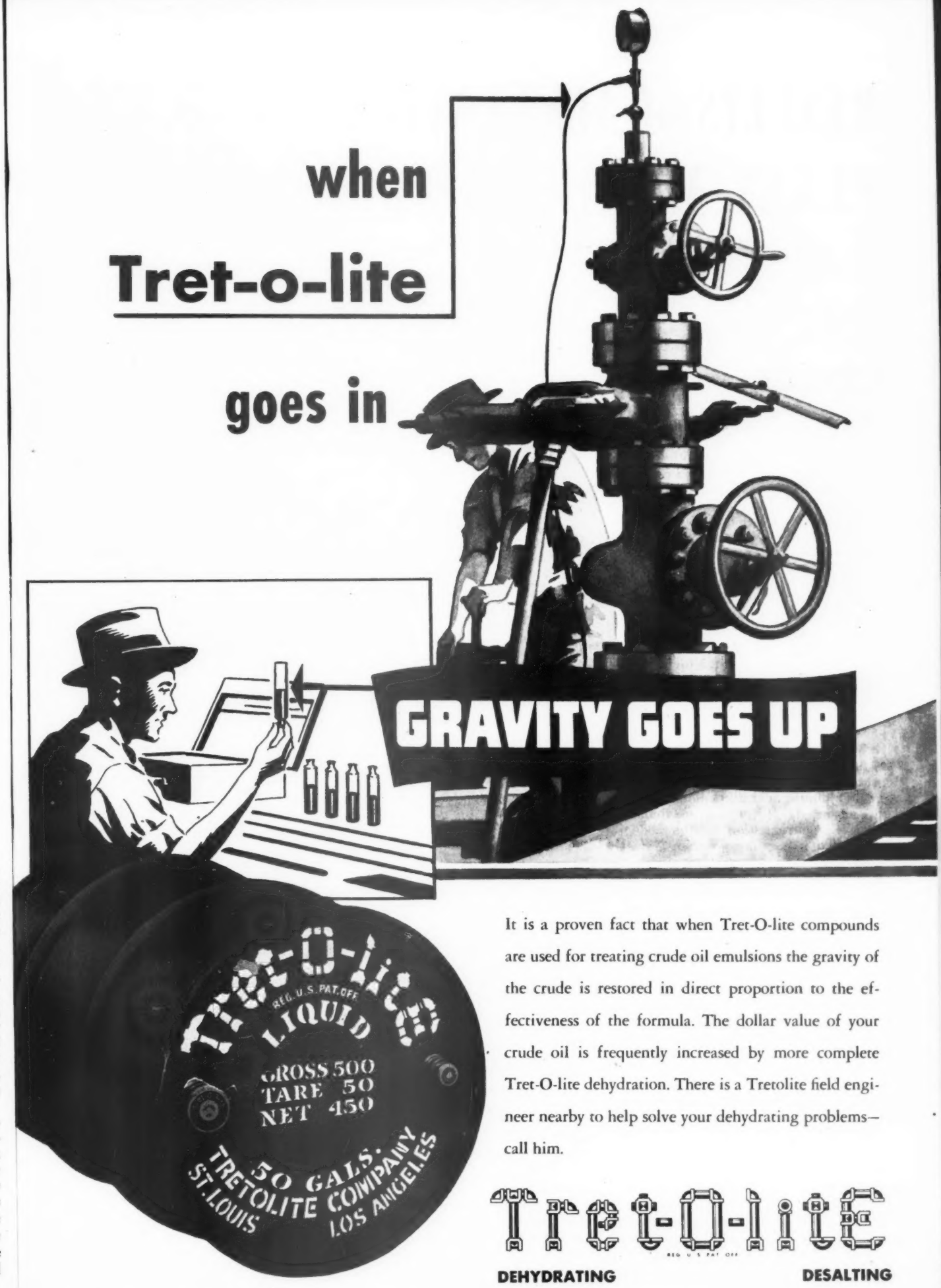

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RESULTS of ALKYLATION PLANT MODIFICATION

Unit originally designed to charge 4190 bbl. a day charges 11,500 bbl. after revisions.

By **JOHN H. KUNKEL,** *Refinery Editor*

EXCLUSIVE

In two recent articles* the writer stated that Jersey's Bayway, New Jersey, refinery, and the refinery in its Southern Works at Baltimore, Maryland, are engaged in a closely controlled, integrated operation for the purpose of maximizing utilization of the products of the Bayway refinery in the 100-octane program.

It was stated that, among other units, the Bayway refinery has a fluid catalytic cracking plant recently modified to increase its throughput from 13,300 bbl. per stream day to about 19,500 bbl. per stream day, and a polymerization plant that, because of its unique design, has, by official statement, made more polymer product than any other U. S. polymerization plant.

Although the Bayway plants mentioned, respectively produce catalytically cracked aviation gasoline base stock, and polymer product for processing into hydro-polymer, they also produce substantial quantities of C_4s and C_5s. As the Bayway refinery does not have alkylation facilities, the C_4s and C_5s are shipped, in pressure tank cars, to the Southern Works at Baltimore for processing into alkylate in that refinery's sulphuric acid alkylation unit. By this means, the objective of maximizing Bayway's participation in the 100-octane aviation gasoline program is realized.

● **History of the alkylation plant.** The Baltimore refinery's sulphuric acid alkylation plant was engineered and designed by the Standard Oil Company of New Jersey, and built by C. F. Braun Company. It was placed on stream November 14, 1942.

The unit was originally designed to alkylate only butenes originating in the Baltimore refinery, the total olefin feed rate to the reactors being 4190 bbl. per stream day. The plant was designed for the production of 2310 bbl. per stream day of depentanized aviation alkylate having an ASTM (motor method) octane number (clear) of 93, final boiling point, 350°F.; heavy alkylate at the rate of 120 bbl. per stream day, and 40 bbl. per stream day of isoC$_5$. The design acid consumption was 50 tons per stream day.

Contrasting with the above figures are those of the January, 1945, average operation in which the charge to the reactors was at 11,500 bbl. per stream day. The unit then was alkylating 70 per cent C_4 olefins and 30 per cent C_5 olefins. Production was limited by available feed stocks. A breakdown of the feeds, is as follows:

	Bbl. per stream day
Baltimore production:	
C_4s	4,000
C_5s	1,300
Bayway production:	
C_4s	4,700
C_5s	1,200
Purchased other source:	
C_4s	300
Total	11,500

In the January, 1945, operation, the plant produced 4055 bbl. per stream day of aviation alkylate having an ASTM (motor method) octane number (clear) of 88.7, final boiling point, 370°F.; 630 bbl. per stream day of heavy alkylate, and 950 bbl. per stream day of isoC$_5$. The acid consumption rate was 320 tons per day.

From the foregoing it will be observed that the Baltimore refinery produced 46 per cent of the unit's January feed that, in bbl. per stream day, slightly exceeded the plant's design feed rate. Bayway supplied 51 per cent of the feed whereas 3 per cent was purchased from outside sources. The feed rate thus, in January, exceeded the design feed rate by nearly 200 per cent. Table 1 details typical inspections of the feed and products.

With respect to make, the aviation alkylate production exceeded design by almost 100 per cent, whereas isoC$_5$ make exceeded design by 2300 per cent. Acid consumption was increased almost 600 per cent. As to the octane number of the aviation alkylate, the January operation shows it as being 4.3 below design, but the loss was more than balanced by the increased production. The final boiling point was increased 20°F. above design to obtain further increase in production.

● **Flow before modifications.** The plant consists of a feed preparation section, a reactor section, and a fractionating section.

Charge to the feed preparation section meets an isoC$_4$ recycle C$_3$ purge stream, from the unit's isobutane tower in the fractionating section, and enters a feed surge drum. A feed pump takes suction on the surge tank to pump the feed as a cold medium through an exchanger in which the hot medium is bottoms from the depropanizer reboiler, thence through a steam preheater and into the depropanizer.

The depropanizer is a 30-tray tower with trays on 24-in. centers. The C_3 overhead passes through 2 water-cooled overhead condensers to a distillate drum. The C_3 overhead from the drum is rejected from the plant, and a reflux pump takes suction on the drum bottom to re-

TABLE 1

Typical inspections of charge and products. (Avg. January operation.)

Feed	Feed, per cent	Recycle isoC$_4$	Spent nC$_4$
C_3	2.2	7.6	..
C_4 unsaturates	14.1	0.0	..
isoC$_4$	37.9	57.7	9.3
nC$_4$	23.8	34.7	87.2
C_5 unsaturates	9.0	0.0	..
isoC$_5$	9.9	0.0	3.5
nC$_5$	3.1	0.0	..
	100.0	100.0	100.0

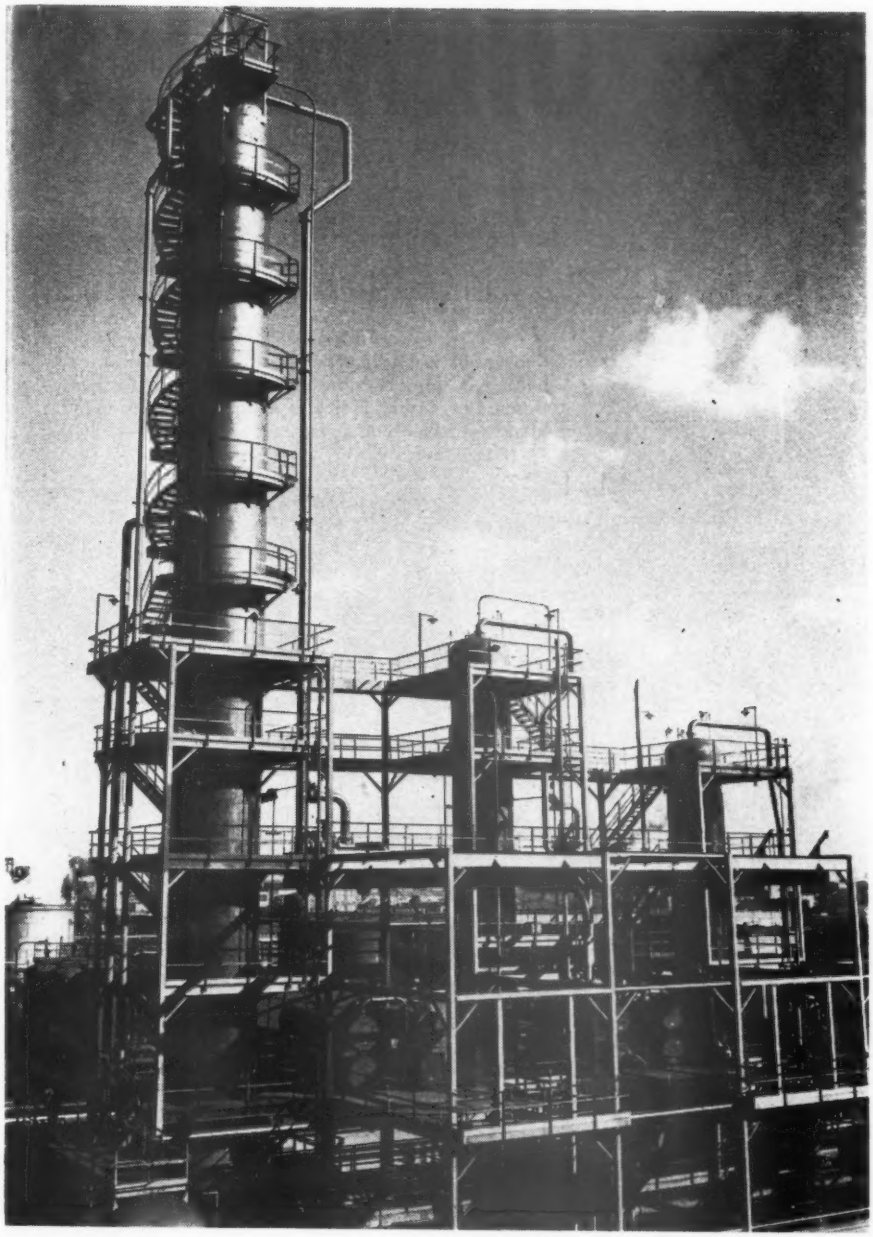
	Aviation alkylate	Heavy alkylate
Gravity, API	71.0	49.0
R.v.p.	5.6	..
Bromine number	0.2	..
IBP	114°F.	380°F.
5 per cent	145°F.	400°F.
50 per cent	235°F.	440°F.
FBP	370°F.	600°F.
1c aviation ASTM (+4.6cc. Pb)—straight	105.0	
3c super rich index no. (+4.6cc. Pb)—straight	137.0	

Average January operation of alkylation plant.

	Design operation	Present operation
Aviation alkylate production, bbl. per day* (depentanized)	2310	4055
Aviation alkylate quality ASTM (MM.) octane no. (clear)	93	88.7
FBP., °F.	350	370
Total olefin feed to reactors, bbl. per day*	4190	11,500
Per cent butene alkylation	100	70
Purchased B-B fed, bbl. per day*	0	5,000
Purchased C$_3$'s fed, bbl. per day*	0	1,200
Max. reactor temp., °F.	40	58
External iC$_4$/ olefin ratio	5.4	2.7
Per cent iC$_4$ in reactor product	55	30
Per cent acid in emulsion	45	46
Acid consumption, T/D*	50	320
Heavy alkylate, bbl. per day*	120	630
Isopentane, bbl. per day*	40	950

*All figures on stream day basis, bbl. per day.

*"How Jersey Standard Increased Cat Cracker Throughput Fifty Per Cent," *The Petroleum Engineer*, July, 1945; and "Bayway Unit Holds Polymer Make Record," *The Petroleum Engineer*, August, 1945.



Isobutane, butane, and alkylate towers of the Jersey Standard Baltimore refinery.

flux the tower over its top tray.

Bottoms from the depropanizer pass through a steam reboiler, through the previously mentioned feed heat exchanger, and a water-cooled bottoms aftercooler, and enter a soda wash drum before entering the reaction section.

● **Reaction section.** The reaction section consists of three olefin feed spheres, a fresh feed drum, an incoming isoC$_4$ recycle exchanger, a feed exchanger, a feed precooler, 3 vertical reactors, 4 reaction coolers, a reactor settler, a final settler, a soda settler, and requisite pumping facilities.

The feed pumps take suction on the olefin feed spheres and the fresh feed drum, to pump feed through a feed exchanger as hot medium against effluent from the final settler, thence through a feed precooler using C$_3$ as refrigerant, and into a settler for removal of moisture.

The feed stream, isobutane recycle, and fresh and recirculated acid enter the bottom of the first reactor, flowing upward in series through the next two vessels. The heat of reaction is dissipated by passing the mixture through coolers, using C$_3$ as refrigerant.

Product from the top of the third reactor enters the reactor settler for separation of the bulk of the hydrocarbon from the acid. Acid from the bottom of the reactor settler is returned to the No. 1 reactor, enough being drawn off to the final settler as spent acid to permit addition of fresh acid to maintain the desired acid strength in the system. The overhead stream from the reaction settler enters the final settler for the removal of acid. Effluent overhead from the final settler passes in parallel through the feed exchangers and the incoming isoC$_4$ exchanger, as cold medium, and then through a soda mixer to a soda settler. Spent soda is withdrawn from this settler to the sewer.

● **Fractionating section.** The fractionating section consists of an isobutane tower with 50 trays on 27-in. centers, a butane tower with 30 trays on 24-in. centers, and a rerun tower having a stripper section in its base and 23 trays on 24-in. centers.

Effluent, overhead from the soda settler, in the reaction section, passes through a steam preheater and into the isobutane tower. IsoC$_4$, as overhead, passes through a water-cooled overhead condenser to a distillate drum on which reflux pumps take suction to pump part of the bottoms back over the tower top as reflux, and part to the reaction section as recycle.

Bottoms from the tower pass through a steam reboiler, a steam preheater, and enter the butane tower. Normal C$_4$ overhead passes through a water-cooled overhead condenser to a distillate drum, a reflux pump taking suction on the drum bottoms to return the C$_4$ over the tower top as reflux or to pump it to a n-butane storage sphere.

Butane tower bottoms pass through a steam reboiler to a preheater and into a rerun tower. The tower overhead passes through a water-cooled overhead condenser to a distillate drum on which a reflux pump takes suction to return part of the drum bottoms over the tower top as reflux. The balance is soda washed in a soda settler, the overhead from which passes through a drum filled with rock salt to remove traces of soda, and then is sent to aviation alkylate storage.

As stated, the rerun tower has a stripping section in its base. Bottoms are circulated through a steam reboiler by a centrifugal pump and a reciprocating pump takes suction on the bottoms, which are after-cooled and go to heavy alkylate storage.

● **Revisions.** As the plant originally was designed for a feed rate of 4190 bbl. per stream day, an increase of the feed rate to 11,500 bbl. per stream day called for added pumping equipment, more heat exchange and condensing capacity, and fractionating tower alterations.

Normally, such additions would present no particular problem. The solution, largely, would be found in the purchase of additional equipment. Under wartime conditions, however, considerable ingenuity was required, for it was necessary to get the maximum from existing plant equipment, to limit the purchase of new equipment to an absolute minimum, and to achieve the desired result without lowering the plant's service factor.

The requirement of pumping more material through the plant was met, mainly, by taking all spare pumps off standby and placing them on stream. To do this, it was necessary to keep a very close check on trouble points and a special inspection schedule was set up to limit maintenance to a minimum.

The plant originally had a feed pump and a spare, but, with both in service, their combined capacity was not suffici-

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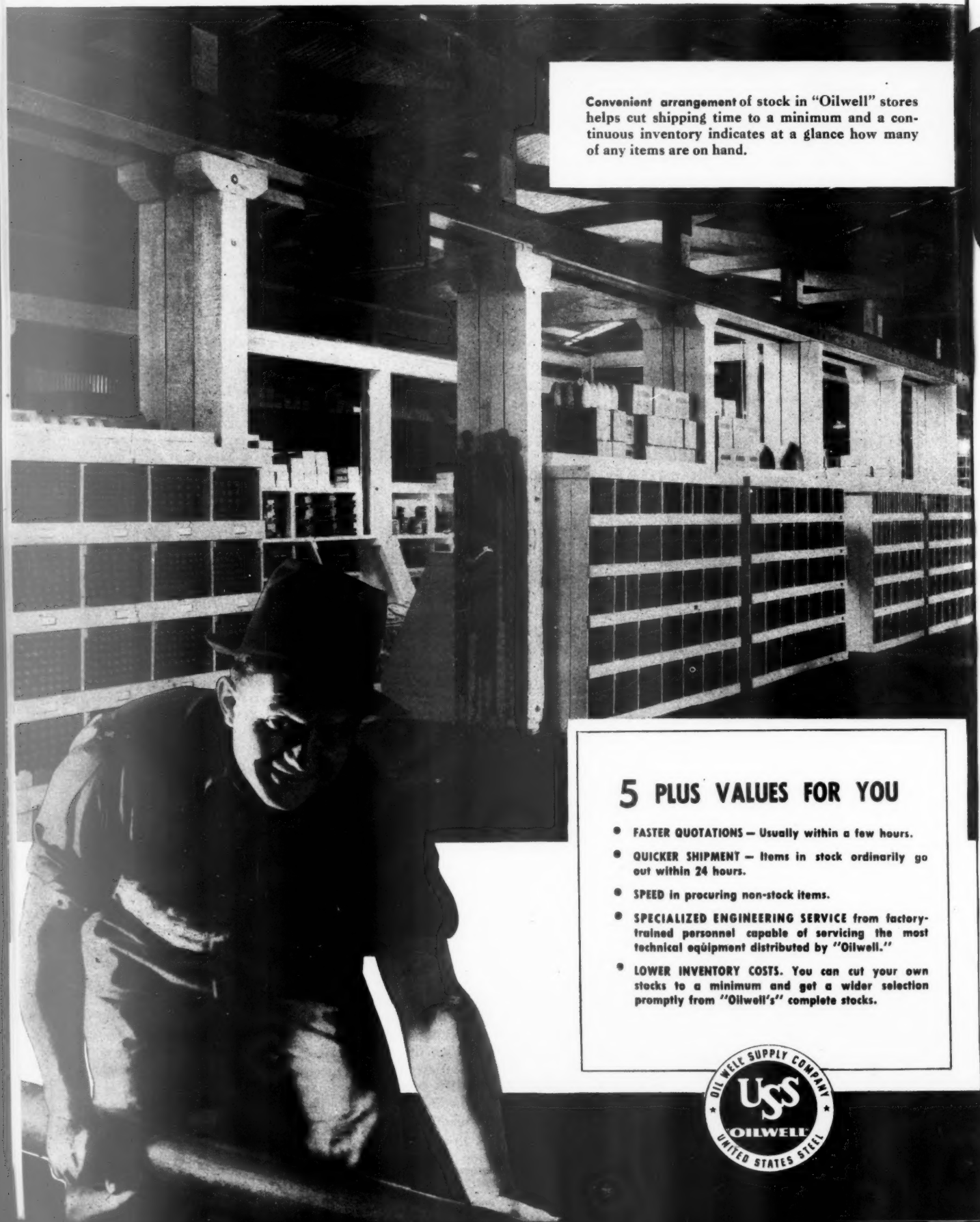

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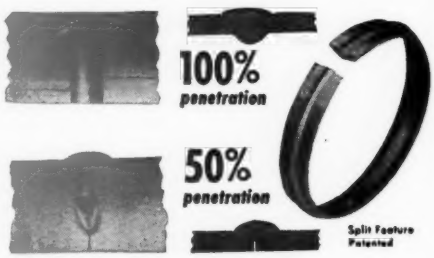

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ent to handle the increased feed rate, and it was necessary to purchase and install a third feed pump, which also was placed on stream.

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The increased throughput in the reactor section called for a correspondingly increased make of isoC$_4$ from the isobutane tower in the fractionating section. Increased production from this tower called for the handling of a larger volume of reflux.

Originally, the isobutane tower was equipped with one reflux pump and spare, and one recycle pump and spare. A survey showed that ordinarily the two reflux pumps have greater capacity than required, and that it would be desirable to increase the recycle stream beyond the capacity of the recycle pumps. Accordingly, connections were made to use the excess reflux pump capacity to augment the capacity of the recycle pumps. At the same time, connections were made to allow the recycle pumps to augment the reflux pumps when this situation is reversed. All 4 pumps are in continuous service.

To withdraw the increased aviation alkylate make from the plant, 2 new high-capacity pumps were installed, replacing this tower's reflux pump and spare, and, in addition, a booster pump was installed. Again, all 3 pumps are in continuous service.

● **Exchangers and condensers.** The depropanizer reboiler was originally designed to use exhaust steam and, in the revision, live steam was substituted, thus increasing the reboiler capacity and permitting increased make of olefin feed as tower bottoms. This increase in bottoms make made it necessary to compensate for a corresponding increase in overhead make by providing more condensing capacity. This was accomplished by revising the baffling in one condenser, arranging the condensers in series, and providing bypasses to permit cleaning the condensers one at a time while the tower continued in operation. The last was accomplished by installing a bypass between the 2 condensers and a side connection from one of the condensers.

The isobutane tower feed preheater was modified to decrease its pressure drop, the net effects being an increase in its capacity and a reduction of the load placed on the feed pumps. As in the case of the depropanizer, the capacity of the reboiler was increased by substituting live steam for exhaust steam.

A new and larger preheater also was installed on the rerun tower.

● **Tower revisions.** Feed nozzles on the isobutane tower were relocated nearer its top to improve stripping. To improve fractionation, internal alterations were made, and these included increasing down-spout clearances and a revision of bell cap blanking. The tower's pressure control was changed and relocated to permit a lower cooling temperature in the condenser and to reduce dezincification of the condenser tubes. A new and larger feed line to the rerun tower was also installed to reduce the load on the stripper in the tower's base.

● **Process revisions.** To ease the load on the rerun column and to facilitate blending of the final aviation gasoline product, which contains large quantities of isoC$_5$, an off-site depentanizer in the refinery's thermal cracking unit was tied into the plant between the butane tower and the rerun tower.

In this revision of flow, butane tower bottoms enter the depentanizer for a close cut separation of the C$_5$s. The depentanizer's overhead, isoC$_5$, is condensed and goes to storage for blending, and the tower bottoms, depentanized total alkylate, are charged to the rerun tower preheater.

Originally the reactor temperature was held at 35 to 40°F. maximum, but due to the refrigeration limitations the reactor temperature is held at 58°F. maximum in the present operation.

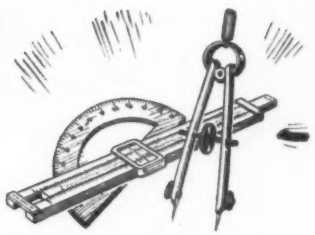
Similarly, the design called for an acid strength of 92 per cent H_2SO_4 whereas, in the operation now conducted, the acid strength is permitted to go as low as 90 per cent before it is discarded. The effect is principally economic but it is believed to result in a slight increase in alkylate make.

● **Service factor.** As has been stated, all spare pumps in the unit are in continuous service. As little would be gained if operations were interrupted frequently due to failure of pumping facilities, a close inspection schedule has been instituted, and its effect can best be judged by the fact that a 90 per cent service factor has been maintained despite the greatly increased throughput and the heavy loads imposed.

● **Acknowledgements.** The writer is indebted to Paul E. Kuhl, general manager of Jersey Standard's Southern Works at Baltimore, Maryland, and W. J. McClintock, general superintendent of the Baltimore refinery, for courtesies extended. He is indebted to H. G. McBurney, assistant general superintendent, H. E. Wilhelm, technical assistant, and W. J. Sheridan, process control engineer, for the data from which this article is written. The writer also wishes to acknowledge the help of R. G. Sloan of Jersey Standard's Public Relations Department who made the necessary interview arrangements for this, as well as the two preceding articles mentioned, and to the personnel of the New York Manufacturing Department for their assistance.

★ ★ ★

DESIGN*



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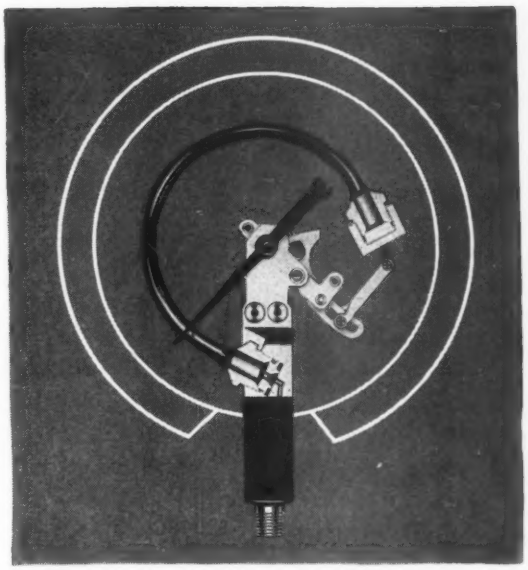

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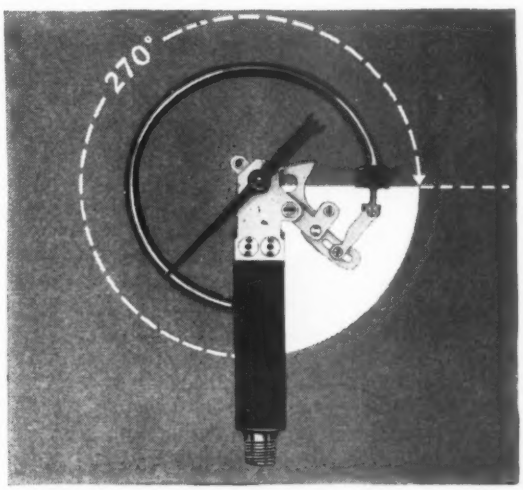

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By **W. L. LOVING,** *Technical Director*
The Cabot Companies

Here is a brief history of the art of manufacturing carbon pigments and of the development of the channel, thermal, and furnace processes, the principal methods of manufacture in use at the present time. The chief use of carbon black is as a reinforcing agent in rubber compounds. The relationship between the carbon black and natural gas industries is discussed and a justification of the use of natural gas for carbon black manufacture is made in opposition to the frequent charge that the carbon black industry is a wasteful user of a natural resource. Predictions are made concerning probable future of the carbon black industry and the effects that availability of natural rubber may have on the requirement of carbons.

EXCLUSIVE

MANY persons not directly connected with the carbon black industry have probably heard about that commodity in recent months due to the publicity received as a result of the shortage of carbon black for the rubber industry. This shortage was so critical that for a few months last spring cuts of 5 to 25 per cent were made in the amounts of carbon black that could be used in tires and other rubber products. This rationing of carbon black resulted in somewhat lower quality products, but did spread the supply so there were few, if any, cases where production suffered from a quantity standpoint. These restrictions have now been lifted and present supplies of carbon black are adequate for all uses.

The temporary shortage served to bring before the public a realization of the importance of a little known product and its essential use in modern warfare and industry. It is paradoxical that so few people recognize the term "carbon black" although it is an important ingredient in every automobile tire and in the ink with which all newspapers and magazines are printed. This is probably due to the fact that carbon black is a raw material rather than a finished product. Also, the industry is comparatively small and its operations are concentrated in a few isolated localities and not conducted on a nationwide basis.

● **Definition.** Carbon black is a generic term covering finely divided amorphous carbon usually produced from natural gas. The qualification "usually produced from natural gas" is added because in the last two or three years a few manufacturers have been in commercial production using processes employing a high percentage of oil as a raw material. The fineness of subdivision, or particle size, of present commercial carbons may vary from 10 to 270 millimicrons, depending on the manufacturing process used. A millimicron is one millionth of a millimeter. This means that one million particles of an average channel type rubber black could be laid in a line and that line would only be 1 in. long! Broadly speaking, lampblacks made from oil and acetylene blacks made from acetylene might be termed carbon black. They exhibit some of the properties of natural gas carbon blacks and, in addition, have peculiar properties of their own that make them particularly suitable for special purposes.

● **Uses of carbon black.** The principal use for carbon black is as a reinforcing agent in rubber products. Approximately 90 per cent of all carbon black is used by the rubber industry. The printing ink industry uses about 5 per cent and the paint and varnish industry about 2 per cent of the total. The remaining 3 per cent is used by the paper, plastic, metallurgical, dry cell battery, and various other industries.

The diversification of these miscellaneous uses may be shown by the following two examples. Several years ago a West Coast real estate promoter purchased a carload of carbon black. Naturally, the sales agents were curious about his use of the product, and they later found that he was interested in having a good rich-looking soil in a new sub-division. Scattering carbon black over the surface was his method of making black soil. A special grade of carbon black has been sold as "Double Bolted Confectioner's Carbon" to candy manufacturers, so if you have eaten some of those very dark rich-looking chocolates, you have probably consumed a small amount of carbon black.

● **History of carbon black.** The history of carbon black of carbonaceous pigments is history itself. Ancient Egyptian, Roman, and Chinese manuscripts written with carbon inks have remained unaltered for thousands of years. The preservation of these carbon pigments is due to the fact that carbon is chemically inert. Many of these early inks were made from carbons obtained from charred bones or vegetable matter. Lampblack had its origin in China where it was obtained by burning oil beneath ceramic pots under carefully regulated conditions and removing the black or soot so produced at frequent intervals. This lampblack was the basis for the Chinese writing stick. Lampblack is still made in China using similar methods.

Between the time of early lampblack manufacture in China and manufacture of carbon black from natural gas in the United States, methods of preparing lampblack, vegetable chars, and bone blacks were developed in European countries although none of these pigments could be considered as impingement process carbon black. About 1825, attempts were made to produce carbon black in England and America from manufactured gas, but none of the processes proved to be economically feasible, and lampblack continued to be the pigment used in printing inks until 1864. At that time, a Philadelphia printer initiated production of carbon black for his own use, his product being made from artificial gas by impinging flames upon a revolving iron cylinder and scraping the carbon off by hand. Incidentally, an improved, but similar process, is still used to produce a specific type of carbon used for high grade lithographic inks.

In 1872, a plant was built in New Cumberland, West Virginia, designed to produce carbon black from natural gas, under patents issued to John Howarth. This plant made use of soapstone slabs cooled by running water as the depositing surfaces on which to collect the carbon produced by natural gas flames impinging upon those slabs. The material was scraped off by hand. The first 500 lb. produced sold for $2.50 per lb.; the next 1000 lb. brought $1.50 per lb., and the plant paid for itself in 3 months. Unfortunately, Howarth made a poor selection of building materials, and the wooden plant burned to the ground. Its successor, built at Saronsburg, Pennsylvania, made use of cast iron rather than soapstone depositing surfaces and employed traveling scrapers.

Between 1872 and 1883, two or three

more manufacturers entered the field, making use of water filled iron pans as collecting surfaces. In 1882, when Samuel Cabot entered the field, carbon black was selling for 31 cents per lb. At that time gas was considered as a waste product. Gas that did not enter the plant was popped to the air. Samuel Cabot initiated a system of flow control whereby part of this waste was eliminated.

In 1887, Godfrey L. Cabot, who had been working for his brother Samuel, purchased the interests and founded Godfrey L. Cabot, Inc. Cabot, now 84 years old, is still acting president of that same company. At that time, the production of carbon black had reached the rate of 1,000,000 lb. a year. By 1892, when McNutt patented the reciprocating channel process, the price of carbon black was down to 6 cents a lb.

● **The channel process.** The channel process patented in 1892 gradually displaced the earlier methods of manufacture although from 1900 to 1914 the Cabot plant at Grantsville, West Virginia, using stationary plates and rotating scrapers and producing 10,000 lb. of carbon a day was the largest single producer. In the channel process, natural gas is burned in small lava tips spaced 4 or 5 in. apart in burner pipes placed about 2½ or 3 in. below reciprocating channels. These channels are built up into "tables" by 8 to 12 channels being placed parallel, spaced about 2 in. apart. The tables range from 100 to 200 ft. in length depending on the type of construction. The channel irons are 6 to 10 in. wide, the 8-in. width being most common. At 4 to 8-ft. intervals, hoppers are placed under the channels, so that stationary scrapers may remove the carbon from the moving channels. The carbon black drops into these hoppers and is removed from the building by screw conveyors. Each table and burner assembly is enclosed in a sheet iron building commonly referred to as a "hot house." Each building may contain as many as 4000 individual burner tips, and present carbon black plants have as many as 300 hot houses. Thus, a plant may contain as many as 1,000,000 tiny bat-wing flames, each producing a minute amount of carbon per day. Each flame is essentially a carbon black furnace with its outer blue sheath where gas is burned completely to provide heat, the intermediate luminous zone where the carbon being produced is incandescent, and the inner reservoir zone that is continuously feeding natural gas to the outer zones. As these tiny flames impinge on the under side of the moving channels, the chemical processes going on within the flame are halted and soot or carbon black is deposited on the relatively cool channel. The fineness of subdivision of channel black particles is attributed to the very short time that it takes for the carbon particle to be removed from the reaction zone after it has been formed; there is little time and chance for the small initial particles to combine into larger clusters or groups.

The carbon black is conveyed by screw conveyors from the hot buildings to packing houses where it is bolted to remove any foreign matter such as sand, mill scale from channels or hard carbon particles. At this stage of the process, the carbon is very fluffy and has an apparent density of about 5 lb. per cu. ft. An agitating process is used to stir the black so that entrained air is removed and the density increased to 10 or 15 lb. per cu. ft. and, if the product is intended for use in inks or paints, it will be packaged at that stage. Most of the carbon black used in rubber at the present time is a 20 to 25 lb. per cu. ft. density product that is formed by various processes into a granular, free-flowing, dustless product, so that it may be handled in bulk with fewer handling difficulties and with less dust.

The annual total production of carbon black reached 20,000,000 lb. by 1915. All of this was produced by impingement processes, and most was made by the reciprocating channel process. During the period from 1900 to 1915 the industry had gradually moved from Pennsylvania to the more prolific gas fields of West Virginia.

● **Initial use in rubber.** Until 1915, carbon black had been used principally as a pigment. One of its uses, however, was in the production of black automobile tires for an industry then in its infancy. For this purpose about 3 parts of carbon per 100 parts of rubber were used. The story has been told that in an English tire plant, a compounder made a mistake and added 30 parts of carbon rather than 3 parts and accidently made an unusually good tire. In any event, by 1920 carbon black became an essential ingredient in tire compounding, replacing a considerable portion of the zinc oxide that had been used as a reinforcing agent. It was, at that time, responsible for at least trebling the life of tires. In 1920, approximately 50,000,000 lb. of carbon black was produced, all by the channel or similar contact methods.

● **The thermal process.** In 1916, a patent was issued to Brownlee and Uhlinger covering a process of bringing natural gas into contact with highly heated refractory material in the absence of air, thus decomposing the gas into carbon and hydrogen. This was the basic patent for the production of so-called thermal-type carbon, and a plant was built in Louisiana in 1922. This plant is still in operation. The process consists of heating a refractory checkerwork to high temperatures with a blast of gas and air and then passing gas through that checkerwork, thus having intermittent heating and cracking cycles. Most of the carbon produced during the cracking cycle passes on through the checkerwork and is collected by bag filters or Cottrell precipitators. The small amount of carbon deposited on the checkerwork during this cracking cycle is burned off during the following heating cycle. An improved process utilizes part of the hydrogen made during the cracking process as a diluent in the following cracking cycle, thereby producing a somewhat finer particle size black. Both of these grades of thermal black have much larger sized particles than grades produced by the contact channel process. Six to 16 lb. of thermal black are produced per 1000 cu. ft. of natural gas. These blacks are sometimes preferred to channel blacks for use in the rubber industry where resistance to abrasion and wear are not important considerations, such as inner tube manufacture.

● **The furnace process.** Measured by particle size and reinforcing ability, the field between the thermal blacks and channel blacks is very large. This field was invaded by the next addition to the carbon black family in 1928 when plants were built in Louisiana and Texas to produce so-called furnace black. These plants burn gas and air in controlled proportions in furnaces using about 50 per cent as much air as is necessary for complete combustion. Thus, part of the gas is consumed to produce heat to decompose the remainder. This general grade of furnace black is now known as SRF (semi-reinforcing furnace) black and, as measured by reinforcing ability and particle size, falls between thermal and channel black. Furnace black yields range from 6 to 14 lb. per 1000 cu. ft. of gas depending on the process used, quality of product, and quality of natural gas.

About 50,000,000 lb. of channel black were produced in 1920. Due to the large growth of the automobile industry and the increased amount of carbon black used in tire compounding, 300,000,000 lb. of channel black were produced in 1930, and 30,000,000 lb. was manufactured by other processes. Approximately 492,000,000 lb. of channel black and 77,000,000 lb. of other blacks were manufactured in 1940. The production of thermal and furnace blacks extends over the period in which the rubber industry has expanded its consumption from 140,000,000 lb. per year in 1928 to more than 3 times that amount in 1941. All tires were made from natural rubber during this period.

● **Synthetic rubber requirements.** The use of carbon black as a reinforcing pigment in natural rubber adds greatly to wear and abrasion properties of the rubber compound. One theory is that the very fine particles of the pigment act as cushions between the relatively large molecules of the rubber. Channel process blacks were used effectively for compounding natural rubber. With the introduction of synthetic rubber after supplies of natural rubber were cut off by entrance of Japan into World War II, the carbon black supply and requirements situation was radically changed. Buna S rubber, the type constituting most of the U. S. synthetic rubber production, is hard to process. It has low reinforcement, low resiliency, and high heat generation properties compared to natural rubber. For many uses, where resistance to abrasion and wear are not of prime importance, natural rubber may be used with very little or no carbon black; however, Buna S

without carbon black is practically worthless and it becomes useful only when carbon black is added as a reinforcing agent.

As an example, natural rubber can be compounded without carbon black to make a compound with a tensile strength of 3200 lb. per sq. in., whereas the compound with the addition of carbon black would have 4000 lb. per sq. in. tensile strength. Buna S compound without carbon black, however, has a tensile strength of less than 200 lb. per sq. in. Addition of carbon black will increase the tensile strength to 3000 lb. per sq. in. Increased quantities of carbon black were required due to increased demand for rubber articles for the war machine, and additional qualities were required due to the necessity of compensating for some of the inherent differences between synthetic and natural rubber. Furnace blacks were immediately in great demand due to their easy processing and low heat generation properties in synthetic rubber compounds. The resistance to abrasion was not all that could be desired but it was better to make tires that would give reasonably good wear than to use hard processing channel blacks and make tires with excellent wear qualities but with such high heat generation properties that they were likely to blow out after a few hours use. Another factor that influenced the demand for furnace type blacks was the fact that for many uses in synthetic rubber 30 parts of furnace black were the equivalent of 10 parts of channel black. This was very important at the time when supplies of both natural and synthetic rubber were at a low ebb; obviously more finished parts could be made if furnace black were used as an extender, as well as a reinforcing pigment.

As a result of continued experience in compounding synthetic rubber, tire manufacturers have found that a combination of channel and furnace type carbons is desirable. There has been a continual improvement in quality of synthetic rubber tires. Much of this is due to improved compounding and improved quality of synthetic rubber made while synthetic rubber plants were continuously operated above rated capacity.

● **Growth of furnace processes.** The demand for furnace blacks for use with synthetic rubber has resulted in two things: (1) many additional furnace black plants have been built, and (2) improved qualities of furnace blacks have been developed that serve to bridge the gap between channel blacks and semi-reinforcing furnace blacks. These new type furnace blacks are an attempt to combine the easy processing, low heat generation properties of furnace black with the good abrasion and high tear resistance properties of channel blacks.

The growth of the furnace black processes as a result of the increased demand for compounding with synthetic rubber has far outstripped the growth of the channel black industry as shown by the following figures: In 1940, furnace and thermal black production amounted to 13.5 per cent of the total of 569,000,000 lb. of carbon black produced; at the end of 1945, carbon black production will be at the rate of approximately 1,240,000,000 lb. a year and half of this will be made by furnace and thermal processes.

● **Carbon black and natural gas industry.** The carbon black industry has been a scavenger industry following the oil production companies from field to field and remaining only so long as gas could be purchased cheaply. The installation of pipe lines that resulted in higher prices for the natural gas has usually caused a migration of the carbon producing industry. The industry has shifted from Pennsylvania to West Virginia to Louisiana to central Texas, and now is in the Texas Panhandle. The fact that carbon black producers paid relatively low prices for natural gas should not automatically condemn them as exploiters. In most cases, and probably in all cases of new fields, the carbon black producer utilized natural gas that was being vented to the air and serving no useful purpose. Also, the carbon black industry has played a part in the development of many gas fields, because the development of the fields would have been delayed in the absence of any demand for gas. Due to the carbon black industry demand for natural gas, however, the gas fields have been developed, and the pipe line interests have been assured of substantial natural reserves, thus causing the carbon producers again to seek new fields. The carbon industry has always utilized a low cost raw material, and in many cases a waste material, to produce a pigment that has always sold at a comparatively low price since the time it became an important compounding ingredient in rubber. These low priced raw materials supplied to the rubber compounders have certainly resulted in cheaper tires to the motoring public.

A high percentage of the natural gas used by the carbon black producers is taken from "sour" gas production areas. By Texas statute, sour gas is defined as any gas containing more than 1.5 grains sulphur per 100 cu. ft. Sour gas is considered unfit for pipe line use, unless the sulphur compounds are removed before introducing the gas into the pipe lines. Sour gas is satisfactory for carbon black production and, in several fields, plants are using gas containing as much as 300 to 400 grains of hydrogen sulphide per 100 cu. ft. This sour gas has no deleterious effect on the carbon produced from such gas although the sulphur content of the black may be a little higher, because many times this amount of sulphur will eventually be used as an ingredient in the compounded rubber. The sour gas does result in a greatly increased rate of deterioration of the carbon plant due to corrosion of equipment, such as burner pipes, channels, and hot buildings in the channel plants; and coolers, precipitating, and collecting equipment in the furnace plants. It is generally considered advantageous to sweeten gas for carbon black production if the gas contains more than 100 grains of sulphur per 100 cu. ft. The decreased rate of deterioration will usually offset the cost of such sweetening. It should be borne in mind that sweetening gas for such use does not mean that all the sulphur compounds need be removed as treatment for pipe line use would require. Reduction to 5 or 10 grains per 100 cu. ft. is usually sufficient. By using this sour gas the carbon black producers have made use of a raw material that might have gone to waste.

● **Economics of the industry.** The carbon black industry has been frequently condemned as wasteful use of a natural resource. Much of this criticism has been due to the clouds of smoke arising from channel plants, and much has been due to the low prices paid for the gas in the past. The latter point has been discussed in an earlier paragraph. The industry should not be adversely criticized just because the channel process obtains only 1.5 lb. of carbon per 1000 cu. ft. of gas used. The present technique of production and distribution is based on the current status of the arts of engineering, physics, chemistry, and administration. Waste occurs only when a given process is operated at a lower level than the state of human knowledge warrants. The product is used in millions of pounds of rubber, cotton cord, and steel bead wire. Other materials are continually being saved by the increased life imparted to tires by the addition of approximately 4 lb. of carbon black per tire. The product is a very necesary raw material in the printing and motor transportation industries.

Most industrial and domestic uses of natural gas as a fuel can be justified economically. Natural gas for those purposes, however, displaces coal, and estimates have been made on a thermal basis that coal reserves constitute 98.8 per cent of our total fuel reserves, oil shales 0.85 per cent, and oil and gas together the remaining 0.35 per cent. On this basis, it might appear uneconomical to use a part of 0.35 per cent of our fuel reserves to displace a part of 98.8 per cent of our fuel reserves.

Although it is true that a thousand cu. ft. of natural gas usually contains 35 to 40 lb. of carbon, and that only 1.5 lb. of carbon black can be recovered from it by the channel process, and that only about 10 lb. of carbon black can be recovered from it by the furnace process, most of the unrecovered portion of carbon burns to supply the energy required to separate the recovered carbon (carbon black) from the hydrocarbon compounds. If this energy were supplied from other sources, such as electrical heat, the percentage recovery of the total carbon would probably be much higher, but such a process might have undesirable effects on the quality of the product for use in synthetic rubber. This result might be predicted by the fact that straight thermal decomposition process blacks are less reinforcing than the furnace and channel process blacks where air is used. Some of the furnace

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   b. Crude fuel flash unit; design capacity 11,000 barrels heavy asphaltic type crude charge per day.

   c. Naphtha reformer unit; design capacity 1,600 barrels naphtha charge per day.

2. 34 unused welded steel tanks, design capacities 1,500 to 10,000 barrels.

3. Unused utilities for above units; transfer piping, blending and leading equipment.

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5. Miscellaneous unused construction tools, including welding equipment, for erection of above units.

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8. Unused oilfield warehouse stock suitable for operation of above units.

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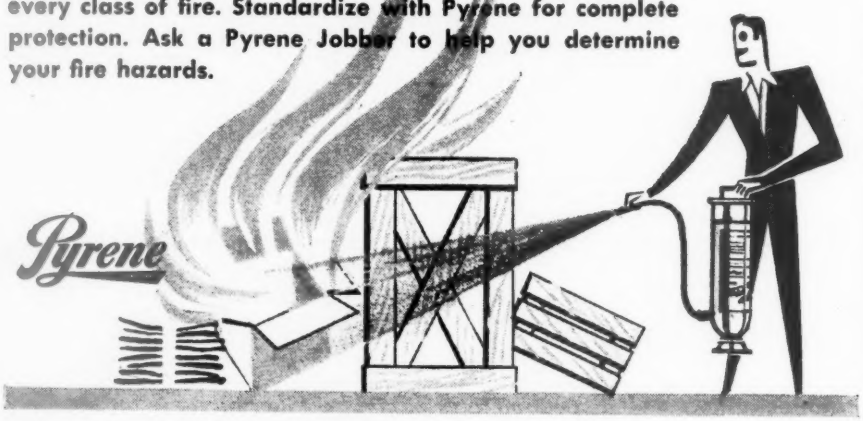

For class "A" fires (fires in ordinary combustible materials—wood, textiles, rubbish, etc.) that frequently occur in warehouses, lumber yards, about farms, in homes, storage spaces or around docks, a Pyrene soda-acid, foam, water or anti-freeze type of extinguisher is recommended, and approved where cooling and quenching effect is of first importance.

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processes obtain a recovery of 30 to 35 per cent of the total carbon in the natural gas which is equivalent to 60 or 70 per cent of theoretical yield, if 50 per cent as much air is used as is required for complete combustion. Many industrial processes are being operated today with much lower efficiency.

● **Outlook for carbon black.** The probable future of the carbon black industry looks bright for the next few years, because it is so closely related to the automotive industry. The demand for rubber products will probably exceed supply for quite some time. Use will be found for all the natural rubber and synthetic rubber that can be obtained for 2 or 3 years. All this will require carbon black. The relative amount of natural and synthetic rubbers used will have some effect on the quantity and quality of carbon blacks required. It is almost certain that further improvements will be made in furnace black qualities, and that they may ultimately approach channel black quality. Yields may be higher than channel black, but may be low compared with present furnace black yields.

The major increase in production capacity, as noted previously, has been in the furnace process plants. The increased production of channel plants will probably be absorbed by increased quantities of natural rubber used, although its field of application may be narrowed in comparison with the prewar period by the availability of suitable furnace blacks at competitive prices. The principal furnace grades may have the advantage of lower unit production costs, due to higher yields, which would encourage their substitution for channel blacks for many purposes for which the two types of black are more or less interchangeable on a quality basis. Furnace grades of carbon black will find new uses, one of which will be the news ink industry where it appears particularly useful on account of its low oil adsorption and where it makes a news ink with a desirable blue-black tone as compared with the brown-black tone ink produced with channel blacks.

The price of natural gas for carbon black manufacture is increasing, and in some areas this may result in making the channel process uneconomical. Due to increased gas, labor, material, and construction costs, the price of carbon black will naturally seek a higher level. This should result in little change in the prices of the finished articles containing carbon black, because comparatively small amounts of carbon black are used to produce substantial improvements.

The carbon black industry is comparatively small, but very aggressive, and is currently devoting much time and energy to research and development intended to improve production methods, improve the quality of its products, develop better carbon blacks for specific uses, and find new uses for all kinds of carbon blacks produced. It is inevitable that many of these goals will be reached.

★ ★ ★

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Chinese Reserves Still a Mystery

OIL reserves in China are more a subject of speculation than of knowledge. The war did not impede progress in exploration, such as it was, to any great extent.

In Kansu, Shensi, Sinkiang, and Szechwan provinces oil has been discovered and some reserves have been proved. Less substantial are the data on oil fields in Chekiang, Kweichow, and Sikang. Oil shale is found in Kwangtung, Shensi, Szechwan, Kwangsi, Shansi, Chahar, Jehol and Liaoning.

Recent development in northern Sinkiang and in the Kansu Corridor has put a new, hopeful version upon once slim estimates of China's oil reserves.

The National Geological Survey of China estimated in 1934 that China Proper had proved reserves of 2,227,000,000 barrels, including 1,375,000,000 barrels in Shensi and Szechwan and 852,000,000 barrels from Shensi oil shale. There were also 2,110,000,000 barrels of oil in the four northeastern provinces, making a national total of 4,337,000,000 barrels.

The United States Geological Survey estimated the Chinese oil reserves at 1,375,000,000 barrels and oil shale at 1,899,000,000 barrels, putting the national total at 3,274,000,000 barrels.

Recent exploration in western Kansu and along the Chilianshan Range give evidence of extensive rich reserves, which will enlarge estimates considerably. Oil fields in Kansu were geologically surveyed in 1934-37. Prospecting work was started by the National Resources Commission in 1938 and drilling began in 1939.

Szechwan also has bright oil prospects. There are abundant indications of oil and fields are found in a number of places.

Two refineries have been established in Kansu, one with three sets of shell stills to produce straight distillates and the other a semi-cracking unit. Both plants are now producing gasoline and some kerosine and diesel oil. Machinery is being moved in from the United States to set up more modern refineries. Sinkiang province has a modern plant by the Tienshan Range.

Many drawbacks hinder the development of Chinese fields and refineries. Machinery is scarce and locally made equipment is used as an expedient. Opening of the world's waterways and availability of American oil field and refinery machinery will give the development of Chinese fields a big impetus.

American personnel will be needed also to instruct and supervise in the use of modern equipment. China has not had an opportunity to train its nationals industrially and they do not have enough skilled labor for the highly technical petroleum industry.

Transportation has been a handicap, with few routes of travel for geological parties and for moving in equipment. The airplane will aid in future surveys and may be used also for transporting much of the machinery.

Estimating China's oil prospects at this time means very little. Exploration so far has been meager; exploitation has been slight indeed. There are boundless possibilities in future development.

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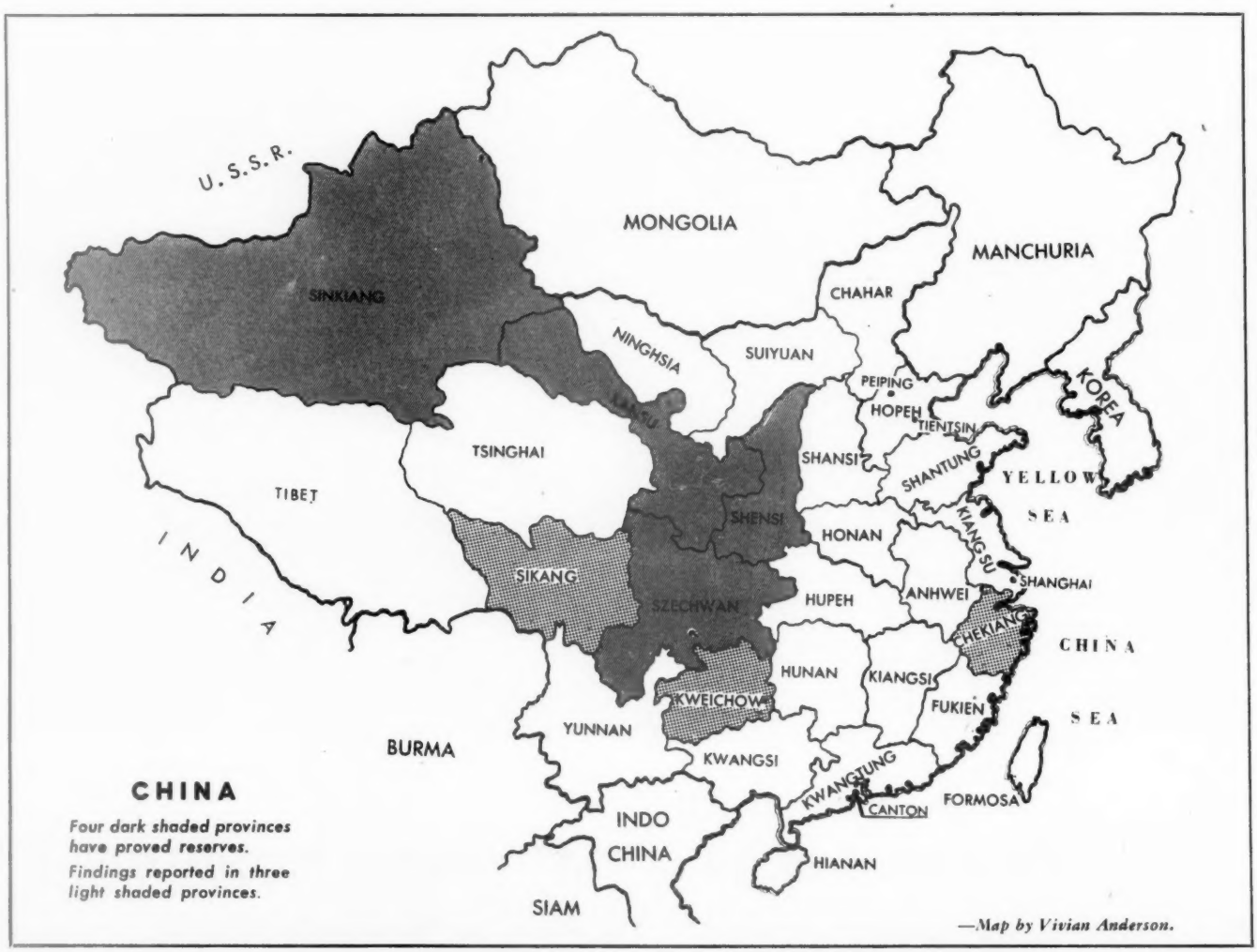

CHINA

Four dark shaded provinces have proved reserves.

Findings reported in three light shaded provinces.

—Map by Vivian Anderson.

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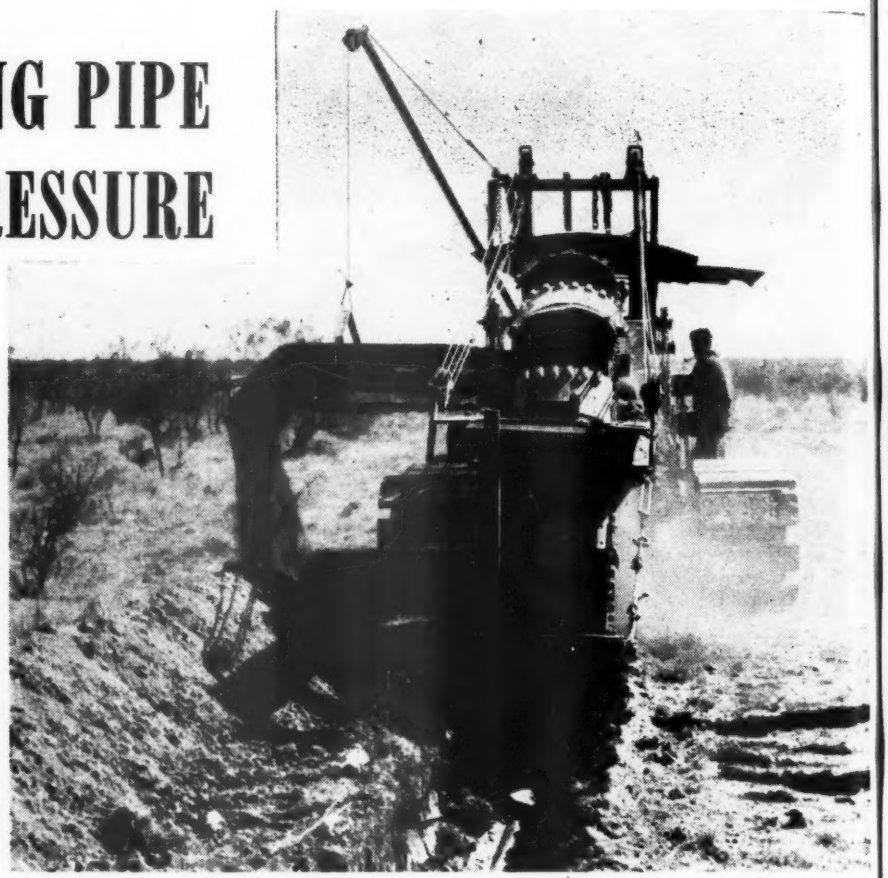
RECONDITIONING PIPE LINE UNDER PRESSURE

FRANK H. LOVE
Managing Editor

Exclusive
Petroleum Engineer
PICTURE STORY



***Above*—First step in reconditioning procedure is to strip the line. This is done with a conventional type ditching machine with shoe attachment to prevent dirt depositing on pipe behind wheel. *Below*—Through rocky areas a special plow removes rock from the pipe.**

AN example of modern over-the ditch reconditioning of an oil pipe line while in operation and thus under pressure is the work being done for Shell Pipe Line Company on a part of its McCamey-Houston, Texas, system by Anderson Brothers, pipe line contractors. The work is in Reagan, Upton, and Crockett counties on the Big Lake-El Dorado section of the line.

EXCLUSIVE

This is a 10-in. line that has been in the ground about 18 years. The line, which was coated when laid, is being raised, completely reconditioned, and recoated before again being lowered in. Throughout the work it has been necessary on only a few occasions to discontinue pumping and drain oil from the line to replace a section of pipe that was too badly corroded and contained too many leaks to be patched successfully.

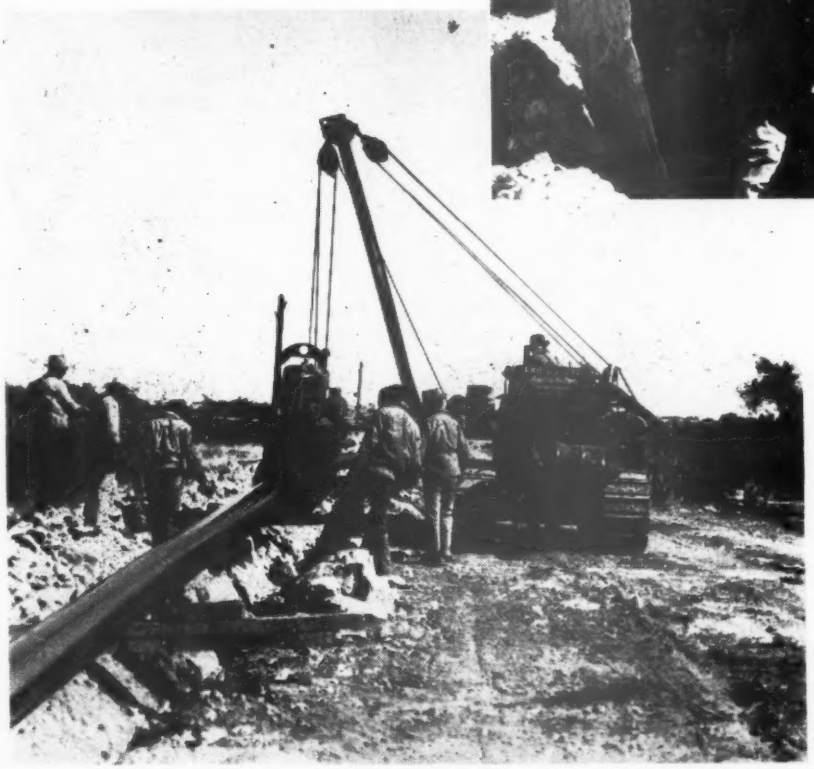
For the most part the pipe is in good enough condition to be patched and the work has progressed rapidly despite the fact that the line is laid in part through extremely rocky soil. The only major delay thus far was two weeks of almost continuous rains.

As the first step in the reconditioning procedure the line is stripped by a ditching machine. The ditcher is of the conventional type except that it is equipped with a shoe that fits the contour of the pipe. This prevents dirt depositing on the pipe behind the wheel of the ditcher cleans around the sides of the pipe, and to some extent helps the ditching machine follow the course of the line.

When the pipe has been uncovered, and before it is raised from the ditch, a metal strap of approximately 4 in. by 6 in. is welded to the topside of each welded joint for reinforcement. In rocky areas the ditching machine removes what rock it can and the remainder is removed by a "plow." This equipment, pulled by a tractor, resembles what its name implies, a plow, but instead of a regular plow blade it has a shoe that fits the top half of the pipe line and rooters that dislodge the rock. The pipe is next

After the line is stripped and before it is raised from the trench a metal strap of approximately 4 in. by 6 in. is welded to the topside of each joint for reinforcement. Here the line has been raised by sideboom tractors and placed on skids above the ditch. After the first cleaning machine has been run another metal strap will be welded to the bottomside of each joint, then more cleaning.

Leaks and corroded areas are repaired by patching, the line remaining in operation and thus under pressure. When a section of pipe is extremely bad it is removed from the line and replaced with new pipe. In such instances the line must be shut down, but this has happened only a few times.

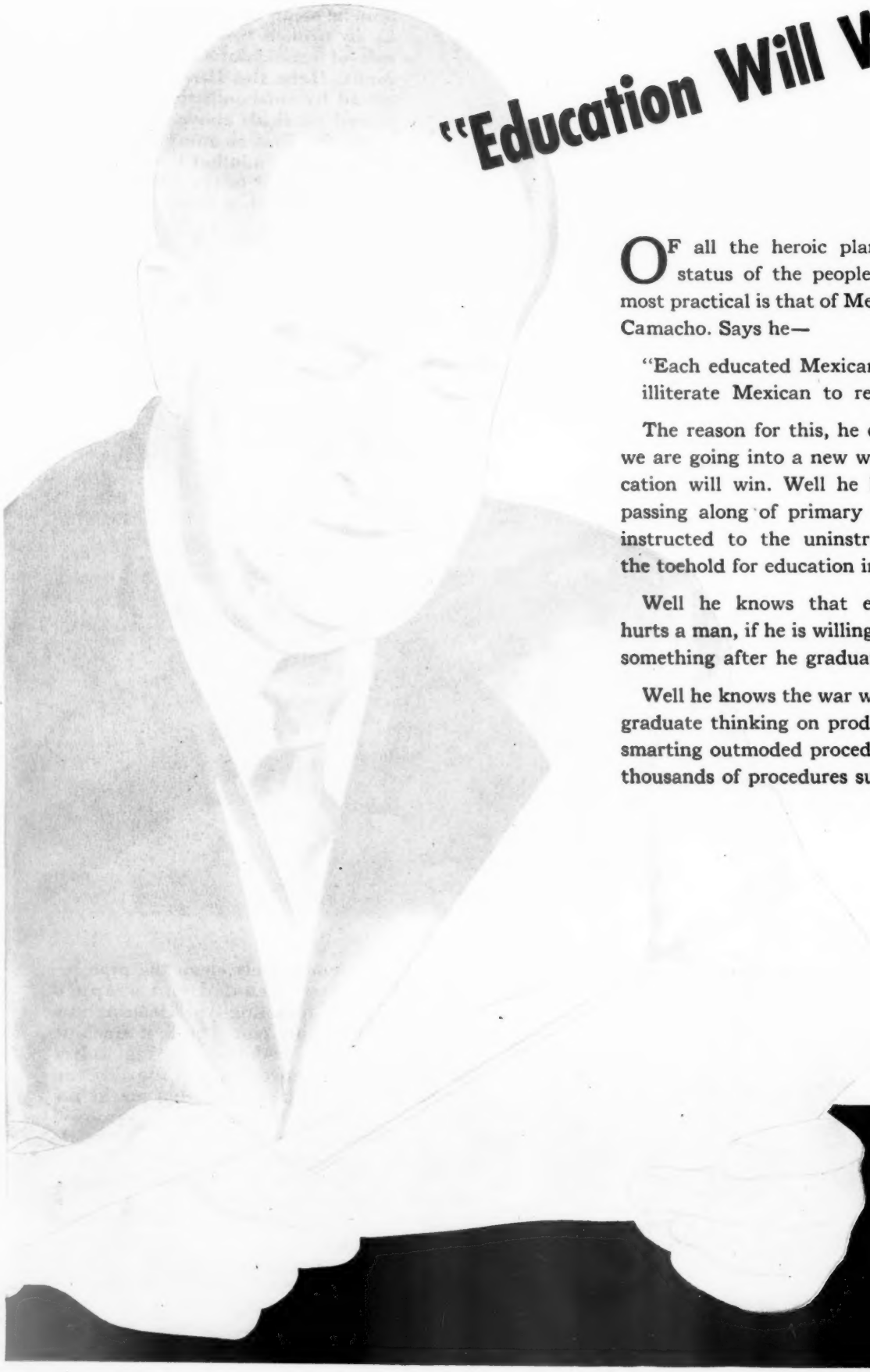


To completely clean the pipe before it is coated and wrapped three traveling-type cleaning machines are run. The first machine is equipped with cutting knives and removes most of the old coating. An inspector then marks the areas to be patched or removed and, after the patches are made by electric welding, the second machine removes any remaining coating and most of the scale and washes the pipe as well. The third machine, which is shown in this photograph, gives the pipe its final cleaning and applies the primer paint.

(Continued on Page 192)

then he said to himself:

"Education Will Win"



OF all the heroic plans to raise the status of the people—simplest and most practical is that of Mexico's President Camacho. Says he—

> "Each educated Mexican is to teach an illiterate Mexican to read and write."

The reason for this, he explains, is that we are going into a new world where education will win. Well he knows that the passing along of primary facts, from the instructed to the uninstructed, provides the toehold for education in any line.

Well he knows that education never hurts a man, if he is willing to learn a little something after he graduates.

Well he knows the war was won by post-graduate thinking on production—by outsmarting outmoded procedures — through thousands of procedures such as—

"TEACH"... *he says*

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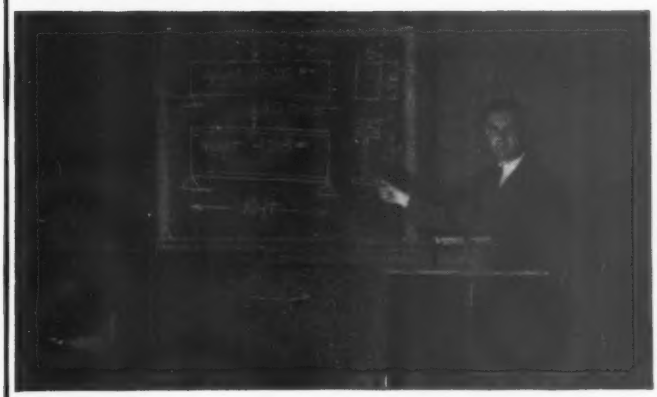

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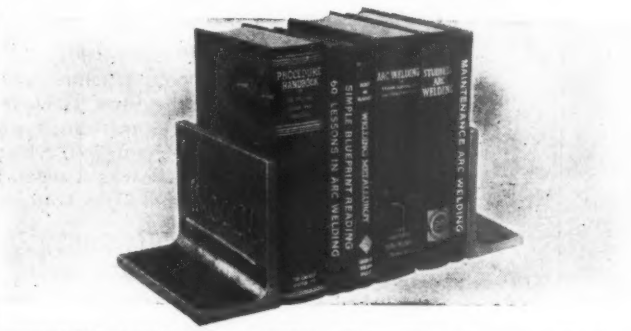

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Above—**The final operation before lowering in is to coat and wrap the pipe. This is done with the traveling-type machine shown here.** *Below*—**The pipe is now completely reconditioned and ready to be lowered into the ditch by sideboom tractors. The only remaining operation is to backfill and clean up the right-of-way. The pipe will now give many more years' service.**

(Continued from Page 189)

raised by two sideboom tractors and placed on skids above the ditch. To clean the pipe completely three traveling-type cleaning machines are employed. After the first machine has been run a second reinforcing strap is welded to the bottom-side of each welded joint.

The first cleaning machine is equipped with cutting knives and removes most of the old coating, making it possible for the inspectors to make a close check of the pipe and determine what areas are to be patched or removed from the line. After the patches are made by electric welding, the second machine removes the remaining coating and most of the scale, and, in addition, is equipped with an attachment that washes the pipe with cleaning solution. The third machine is equipped with steel brushes and a priming head, giving the pipe its final cleaning and applying the primer paint.

A traveling-type coating and wrapping machine applies coal tar enamel coating and wraps the pipe spirally with asbestos felt. This operation is followed by a holiday detector and any defects thus found in the coating are repaired.

Before lowering in the ditch is padded with dirt in the rocky areas to prevent damage to coating. A 24-in. covering is being given the pipe.

The final operation is to backfill and clean up the right-of-way.

Various steps in the over-the-ditch reconditioning procedure, which will put the pipe in condition for many more years of efficient operation, are shown.

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FEDERAL MINERAL LEASING ACT

By EMERY CARPER*

I HAVE been requested to give a resume of the provisions of the Federal Mineral Leasing Act and of the bills pending in Congress that propose to amend the act.

The public domain of the United States consists of approximately 335,000,000 acres, mostly situated in the states of New Mexico, Colorado, Wyoming, Arizona, Nevada, California, Utah, Oregon, and Washington. The oil industry naturally is interested in the manner in which the federal government offers to lease these lands for oil and gas as much of the land is in potential oil bearing areas. There are a number of major fields situated wholly or partially upon the public domain; however, there are large areas of the public domain upon which there has been relatively little, if any, prospecting.

The Constitution of the United States gives Congress the right to dispose of public lands. In 1862 Congress passed what was known as the Homestead Law giving the right to a head of a family to acquire 160 acres of the public domain by maintaining a residence thereon for 5 years. This was later changed so as to give the same right to any citizen of the United States and was thereafter extended to include 320 acres, and by a subsequent act homesteaders were permitted to acquire the surface rights to an additional 640 acres of grazing land. It was not until the passage of the Act of Congress approved February 25, 1920, entitled "An Act to Permit the Mining of Coal, Phosphate, Oil, Oil Shale, Gas and Sodium on the Public Domain" commonly referred to as 'The Mineral Leasing Act,' that the Congress formulated a definite policy on the exploration and development of the public domain for oil and gas and other minerals. Under this act the Secretary of the Interior was authorized under such rules and regulations as might be prescribed by him to issue a permit to any citizen of the United States or to any association of citizens or any corporation organized under the laws of the United States or under the laws of any state or territory to prospect for oil and gas. Permits were issued for not exceding 2560 acres of lands not within the known geological structure of a producing oil or gas field. Permittees were granted the exclusive right to explore and develop the permitted lands for oil and gas for a period of 2 years, upon the condition that a well be commenced within 6 months from the date of the permit and that such well be drilled to a depth of at least 500 ft. within one year, and to a depth of not less than 2000 ft. within 2 years, unless oil or gas should be discovered at a lesser depth. As a reward for the discovery of valuable deposits of oil or gas the permittee was entitled to a lease on one-fourth of the lands embraced in the permit at a royalty to the United States of 5 per cent, and was also entitled to a preference right to a lease for the remainder of the land in the permit at a royalty to the United States of not less than 12½ per cent. The leases providing for a royalty to the United States of 5 per cent were known as the "preferred area" or "A" leases and the leases upon the remainder of the lands were known as "non-preferred area" or "B" leases. By regulations the Secretary of the Interior prescribed a royalty rate for the B leases on a sliding scale basis ranging from 12½ to 33⅓ depending upon the average daily production per well for each calendar month and the gravity of the oil produced. The Leasing Act required all leases to be issued for a term of "20 years with the preferential right in the leasee to renew the same for successive periods of 10 years upon such reasonable terms and conditions as may be prescribe by the Secretary of the Interior, unless otherwise provided by law at the time of the expiration of such periods."

The Secretary of the Interior was authorized to grant extensions of time not exceeding 2 years within which to comply with the drilling requirements of permits. Successive acts of Congress were passed permitting like extensions and in many instances permits were kept alive by successive extensions from the time permits were first issued until the passage of the amendment of August 21, 1935, without complying with the drilling requirement of the permits.

The Leasing Act as originally drafted limited the amount of holdings of any individual or corporation to 3 oil and gas leases in any one state and not more than 1 lease within the geological structure of the same producing oil or gas field. This was amended in 1926 to permit any individual or corporation to hold leases or permits aggregating 7680 acres in any one state but not more than 2560 acres within the geological structure of the same producing field.

The Department of the Interior by interpretation of the provisions prescribing the acreage limitations construed the act to permit an individual or corportation to acquire operating agreements covering oil and gas permits without regard to the acreage limitations until such time as a discovery was made and then the operator was required to disclose and to limit his holdings directly or indirectly to 2560 acres on the structure upon which the discovery was made. As a result of this interpretation or ruling of the Department of the Interior many operators, both individuals and corporations, acquired operating agreements covering large areas of the public domain. Through this interpretation of the act development was encouraged in that it permitted operators to acquire relatively large blocks upon which to drill wildcat tests.

In 1930 the Leasing Act was amended to permit the operation of any pool or field under a unit or other cooperative agreement and in 1935 the act was further amended expressly to provide that all leases operated under a cooperative or unit plan should be expected in determining holdings or control under the acreage limitations of the act. The 1935 amendment made it discretionary with the Secretary of the Interior to require any federal lease to be conditioned upon an agreement by the lessee to operate the lands embraced therein under a cooperative or unit plan determined by the Secretary to be practicable or necessary or advisable and all leases subsequently issued were so conditioned, such leases in fact, providing for compulsory unitization where prescribed by the Secretary.

Operations for the exploration and development of the public domain were conducted under the permit system until August 21, 1935, at which time Congress amended the mineral leasing act to provide for the issuance of oil and gas in lieu of permits. Under the new system inaugurated by the 1935 act, which, except for some minor amendments, is the system in effect today, the first person applying to lease open lands not within the known geological structure of a producing oil or gas field is given a preference right to a lease for a term of 5 years and as long thereafter as oil and gas is produced in paying quantities. Where the lands are within the known geological structure of a producing oil or gas field the lands are

*Presented at IPAA meeting, Tulsa, Oklahoma.

offered to the highest bidder and the leases upon these lands are issued for a period of 10 years and so long thereafter as oil or gas is produced in paying quantities. These leases provide for a royalty to the United States on a step scale basis ranging from 12½ to 25 per cent, depending upon the average daily production per well for each calendar month and the price of oil. The applicant is required to pay a small filing fee upon making application and one-half of the initial rental of 50 cents an acre. The rentals for subsequent lease years are on the basis of 25 cents an acre; however, the rental for the second and third lease years are waived unless production is obtained during that period. Beginning with the lease year after production is obtained rentals are paid on the basis of $1 per acre, the rentals paid for any lease year being credited upon the royalties due the United States for that year.

The owners of all oil and gas permits maintained in good standing and upon which a discovery had not been made prior to the passage of the amendment of August 21, 1935, were permitted by the amendment to exchange such permits for 5-year leases as prescribed by the amendment without proof of discovery and such exchange leases were not subject to the acreage limitations of the Leasing Act until one year after the discovery of oil or gas.

After the passage of the amendment of August 21, 1935, the Department of the Interior completely reversed itself in its policy with respect to permitting operations to be carried on under operating agreements without regard to the acreage limitations of the act, by holding that an operating agreement covering an oil and gas lease issued pursuant to the 1935 amendment would be regarded as a direct holding and chargeable under the acreage limitations of the act. As a result of this decision of the Department of the Interior, operators who had acquired operating agreements covering oil and gas permits embracing large areas of the public domain found themselves in a situation that would no longer permit them to hold large blocks indirectly through operating agreements. As an outgrowth of this, there has developed a practice, which has been more or less recognized by the Department, of taking option agreements to purchase oil and gas leases covering federal lands for a reasonable period of time, in most instances 18 months to 2 years. Usually such agreements provide that during the term of the option the optionee is given the right to perform certain geological or geophysical work to determine the feasibility of forming a cooperative or unit plan embracing the acreage covered by the option. These agreements are sometimes referred to as "shooting options" and it would appear where they are entered into in good faith for these purposes for a reasonable time, that the acreage covered by the same is not chargeable under the acreage limitations of the Leasing Act. It has only been through this device in many areas that legitimate operators have been permitted to get together a sufficient block to justify the drilling of deep and expensive wildcat wells.

The Mineral Leasing Act confers broad powers upon the Secretary of the Interior and authorizes him "to prescribe necessary and proper rules and regulations and to do any and all things necessary to carry out and accomplish the purposes" of the act, and also "to fix and determine the boundary lines of any structure or oil or gas field for the purposes" of the act. The Secretary has gone so far in prescribing the form of lease to be issued expressly to provide in the lease that the lessee agrees: "to abide by and conform to any and all reasonable regulations of the Secretary of the Interior now or hereafter in force, all of which regulations are made a part and condition of" the lease. It will be noticed that the leasee not only agrees to abide by regulations in force at the time the lease is issued but by all regulations that may subsequently be issued by the Secretary.

On March 9, 1942, the Secretary approved regulations promulgated by the Department providing in effect that no overriding royalty should be created in excess of 5 per cent and forbidding the creation of any obligation payable out of production that might constitute a burden on lease operations prejudicial to the interests of the United States. Although a complete code of federal regulations has been issued by the Secretary governing operations conducted on federal lands and providing for well spacing, well casing, and other programs designed to encourage conservation of oil and gas, by properly drilling and plugging wells, the issuance of these regulations limiting the amount of overriding royalty and obligations payable out of production that might be created by the lease owner, was the first departure from the well established rule in the oil industry that a lease owner has the right to do whatever he chooses with his working interest oil and gas. This regulation was put into effect under the guise that it would prevent the premature abandonment of stripper wells by operators who had loaded their lease up with overriding royalties and obligations payable out of production. As a matter of fact, however, the Secretary of the Interior had already prescribed regulations under which a well could not be abandoned without his consent, and provided for the scaling down of government royalties in the case of stripper wells on the condition that outstanding royalty obligations likewise be scaled down to permit the operation of such wells on a paying basis.

The Secretary under the broad powers given to him by the Leasing Act has also undertaken to prescribe regulations under which he may establish reasonable minimum prices to compute the value of royalty oil and gas.

It is not likely that the Congress intended in the passage of the Leasing Act and amendments thereto to confer upon the Secretary of the Interior powers that permit him, in effect, to dictate to the lessee the conditions under which the lessee shall operate his leasehold premises, insofar as payments that are to be made out of the working interest oil and gas, and the price to be paid for royalty oil and gas, are concerned. There has been much criticism of these regulations and protests to the Secretary and other officials of the Department. They have not, however, been changed or modified.

On July 29, 1942, Congress passed an act providing, in effect, that upon expiration of the 5-year term of any noncompetitive oil and gas lease issued pursuant to the provisions of the 1935 amendment and maintained in good standing that the owner thereof should have a preference right over others to a new lease by making application therefor within 90 days prior to the date of expiration of the existing lease. Under the express provisions of this act the preference right does not apply "to lands which on the date of the expiration of the lease are within the known geologic structure of a producing oil or gas field." In 1943 and again in 1944 Congress passed acts extending for a year leases for which no preference right was granted under the 1942 act, that is, leases that embrace lands within the known geologic structure of a producing oil or gas field. As a result of these acts, leases embracing lands within a known field upon which production has not been obtained have been extended to December 31, 1945. Senator Hatch of New Mexico and Senator O'Mahoney of Wyoming have just recently introduced a similar bill (S.B. 1459 October 3, 1945) providing for a like extension, of oil and gas leases embracing lands within a proved field, to December 31, 1946. The necessity for

400-mile wildcat program

With the aim of opening new oil fields immediately adjacent to the Rocky Mountains front along the east slope of the mountains, major oil companies have opened one of the most spectacular wildcatting campaigns in northwest oil history along a 400-mile front 15 miles wide extending from Augusta, Montana, to Jasper National Park, Alberta, Canada. Previous attempts to locate buried structures by a study of surface outcrops have been failures—with the exception of the Turner Valley field, which has yielded more than 75,000,000 bbl. of high-gravity oil. In Alberta firms that have leased large blocks of acreage are drilling or have geophysical parties in action include the Gulf Oil Company, The Texas Company, Pure Oil, Sun Oil, Shell, Standard of California and others.

these extensions has to some extent been brought about by a decision of the department holding, in effect, that where portions of an oil and gas lease have been assigned and the assignments approved and given separate serial numbers that a discovery on one portion of the lands in the lease will not validate the other lands in the lease or extend the lease as to such lands beyond the 5-year term.

This ruling is just the opposite from the great majority of court decisions in similar cases dealing with leases upon privately owned or state lands. The courts have rather uniformly held and it has been recognized by the industry generally as a factor in the development of oil and gas properties, that production obtained upon any part of the land embraced in a lease will continue the lease in full force and effect as to all the lands embraced therein regardless of whether portions of the lands have been assigned. This decision carried to its logical conclusion means that if an operator has developed production on federal lands he is not permitted after the expiration of the primary term of 5 years to assign the lease as to any undeveloped portion thereof. In such a case the only way that the lease owner can dispose of undeveloped portions of a lease is to farm it out under an operating agreement by which the lease owner reserves a royalty interest so that he may retain the legal title to the lease insofar as the Department of the Interior is concerned. This is a situation that has no parallel in the history of the industry and is entirely contrary to the general principles upon which the industry has always operated and principles that have been laid down by the courts. By this ruling, with the sanction of the Department, lease owners have been forced to resort to a device or subterfuge to do indirectly that which they are not permitted to do directly.

The Secretary of the Interior in the administration of the Leasing Act, so to speak, is the judge, the jury, and the prosecutor, there being no direct method by which a lease owner may seek redress in the courts or appeal to the courts from any decision or ruling of the Secretary. Although there have been relatively few, if any, flagrant abuses of authority of the Secretary or officials of the Department of the Interior in the administration of the Leasing Act, the fact that the Secretary has such broad power and authority that a lease owner is virtually at the mercy of the Secretary, coupled with such regulations and decisions that have been mentioned and that are radical departures from the general practice in the oil industry, are in themselves factors that greatly deter the development of the public domain. These factors have prevented many legitimate operators from becoming interested in prospecting and developing the public domain. So long as these lands belong to the United States they should be administered in a manner to encourage as much prospecting and development as possible, and outside of the conservation principles that may be involved, the Secretary should not be given any greater rights than are customarily retained by any proprietor of lands in leasing the same.

There has been for some time a movement on foot either to revise completely the federal mineral leasing act or to liberalize the provision thereof to overcome some of the objections mentioned. Senators Hatch and O'Mahoney on July 6 of this year introduced Senate Bill 1236 entitled "A Bill to Promote the Development of Oil and Gas on the Public Domain and on Lands Acquired for the Appalachian National Forest and for Other Purposes." This bill amends certain sections of the federal mineral leasing act. An analysis of the Bill reveals the following changes:

All lands to be leased within any known geologic structure of a producing oil or gas field are to be offered to the highest responsible, qualified bidder by competitive bidding in units not exceeding 640 acres and any lease so issued is not to be chargeable under the acreage limitations of the Leasing Act. Such leases are to be issued for a period of 10 years and so long thereafter as oil or gas is produced in paying quantities, and are to provide for a royalty of not less than 12½ per cent in amount or value of production to be fixed by the Secretary of the Interior.

2. All lands not within the known

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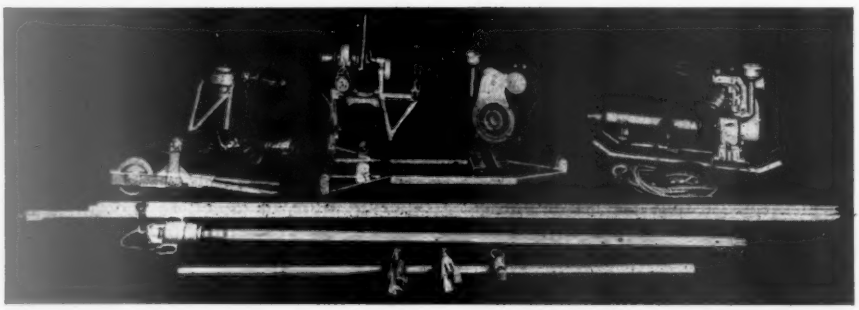

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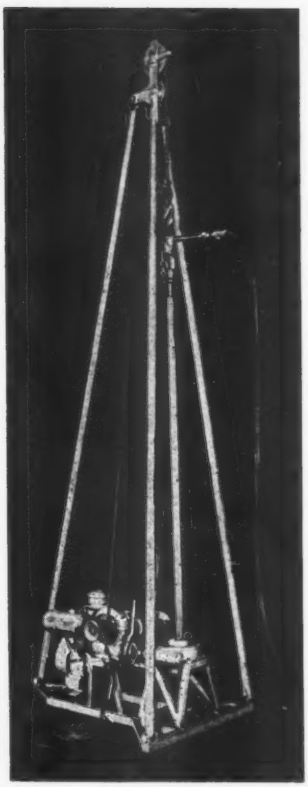

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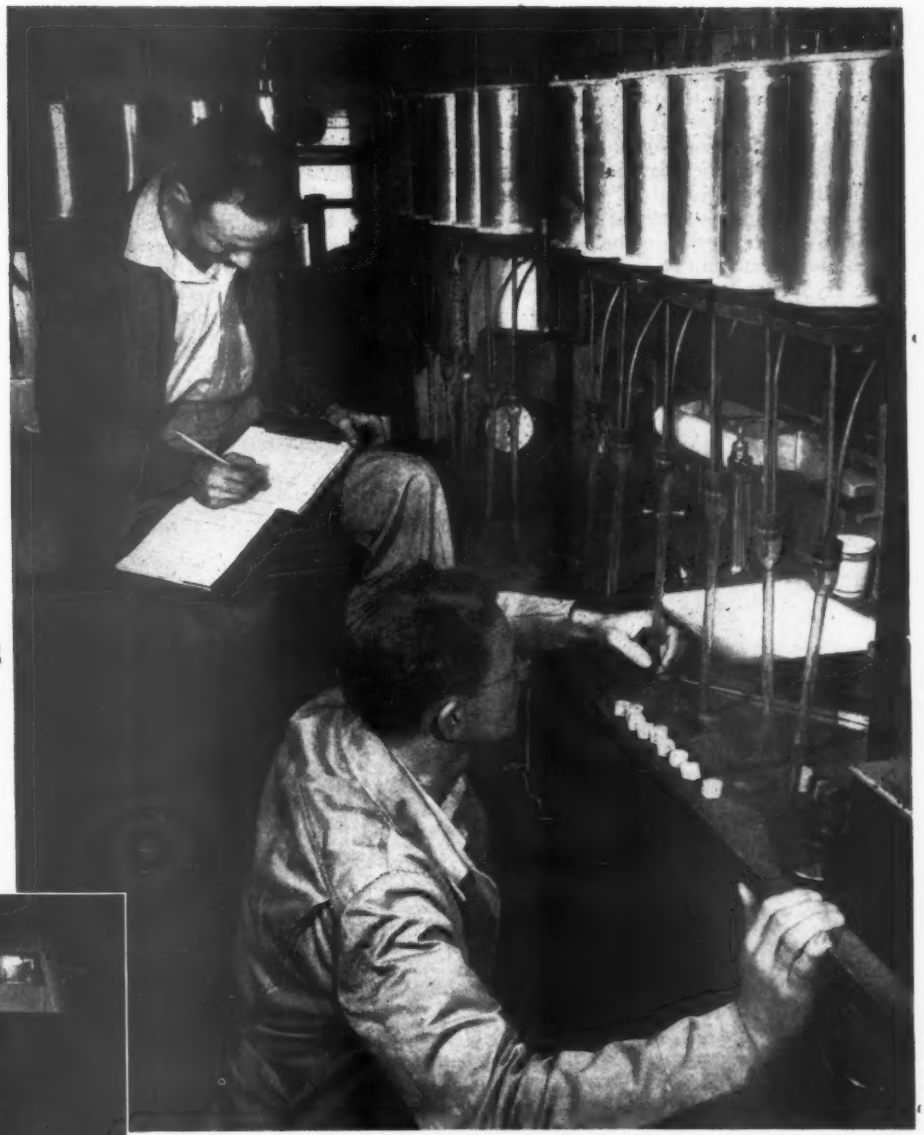

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geologic structure of a producing oil or gas field are to be leased to the first qualified person making application therefor without competitive bidding and are to be for a term of 5 years and so long thereafter as oil or gas is produced in paying quantities and are to be conditioned upon the payment of a royalty in the case of oil of 12½ per cent when the production does not exceed 50 bbl. a day per well for the calendar month and an amount to be fixed by the Secretary of not less than 12½ per cent when the production exceeds 50 bbl. a well per day for the calendar month.

3. The owner of any lease providing for an initial term of 5 years is entitled to a preference right over others to a new lease for an additional period of 5 years provided that an application is made for such renewal within 90 days prior to the expiration of the initial 5-year period. Only one renewal is to be permitted. However, any lease that is not subject to renewal and on which drilling operations are being conducted at the expiration of the primary term of the lease is to be continued in force and effect for an additional period of 2 years, and so long thereafter as oil or gas is produced in paying quantities.

4. All leases are to provide for the payment by the lessee of an annual rental of not less than 25 cents an acre per annum prior to discovery, the amount thereof to be fixed by regulations of the Secretary of the Interior and a minimum royalty of $1 per acre payable at the expiration of each period of 12 full calendar months after discovery. In cases where the lands are not within a known geologic structure of a producing oil or gas field the rentals are waived for the second and third lease years unless a valuable deposit of oil or gas is discovered during that period.

5. In cases where new fields or deposits of oil or gas have been discovered after May 27, 1941, either by a well drilled within the boundaries of any lease requiring the payment of royalty to the United States in excess of 12½ per cent or by a well drilled within 2 miles of the boundary of any such lease where the lease owner has contributed to the drilling of such well or would have contributed had the well been non-productive, the royalty obligation to the United States of the leasee who drilled such well or who contributed or would have contributed to such well, is to be reduced to a flat 12½ per cent.

6. All leases issued for a term of 20 years under the permit system as a reward for the discovery of valuable deposits of oil or gas on permitted lands, are to be continued in full force and effect where such leases have been committed to a cooperative or unit plan of development, until the termination of such plan.

7. When any cooperative or unit plan of development includes lands of the United States the same may, at the discretion of the Secretary of the Interior, contain a provision whereby authority is vested in such person, committee or state or federal official or agency as may be designated in the plan, to alter or modify from time to time the rate of prospecting and developing and the quantity and rate of production under such plan. The Secretary would also be given authority, when necessary or in the public interest, with the consent of the lessee, to suspend or modify the drilling or producing requirements of any lease and it is expressly provided that no lease shall be deemed to expire by reason of such suspension or production pursuant to any such order.

8. The acreage limitations are increased to permit any person, association, or corporation to hold oil and gas leases aggregating 15,360 acres in any one state. The acreage limitation on the amount of acreage that one may hold in any one field or pool would be removed.

9. Option agreements for the purchase of one or more oil and gas lease "when coupled with the express obligation to conduct geophysical examination of the leased land" are not to be chargeable under the acreage limitations of the act. Such option agreements shall not be entered into for a period of more than 2 years, however, without the prior approval of the Secretary and no person, association, or corporation shall hold, at any one time, option agreements covering more than 100,000 acres in any one state.

10. All leases may be assigned or subleased in whole or in part with the ap-

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Fig. F476 Fig. F481

For the Close Hole Job
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SOLID BORED FRICTION SOCKET
(Fig. F 476)
and MULTI-SLIP COLLAR SOCKET
(Fig. F 481)

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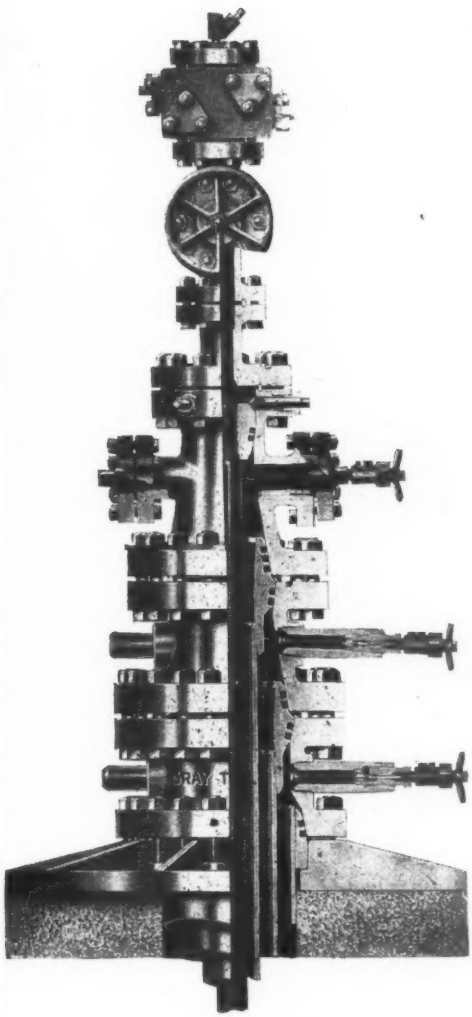

FIGURE 1A

Complete Well Head Assembly equipped with Composite Manifold, Valve Removal, Installation and Removal.

Anticipate the unusual conditions for which control should be provided!

Provision for the assembling and disassembling of control equipment with control at the time the equipment has completed its control function and other equipment is needed provides the ability to meet unusual conditions during and subsequent to completion as they arise.

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These systems are coordinated methods, providing the highest degree of control and operating efficiency for performing the entire sequence of operations from drilling through producing the well. There is no gap in control when you use Gray Systems of Well Control.

The whole is greater than any of its parts. The problem of meeting unusual conditions disappears when you have the wider choice of equipment made possible by provision for assembling and disassembling equipment with control!

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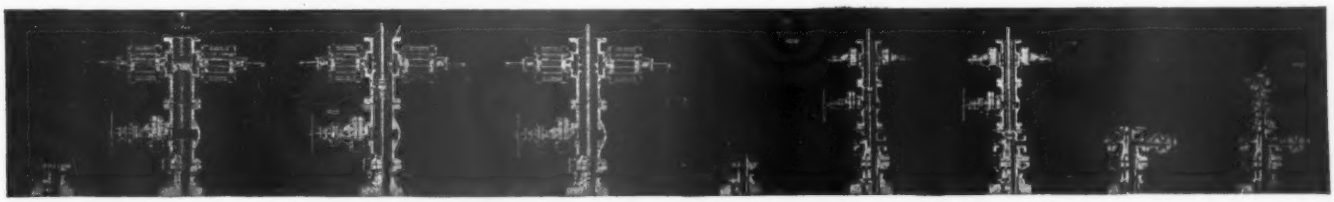

Casing Head Attached | Drilling | Running Casing | Casing Landed | Drilling Control Equipment Removed | Drilling-In and Running Tubing | Tubing Landed | Control Equipment Removed | Manifold Attached

proval of the Secretary and are to take effect as of the date of the filing in the proper land office. Upon approval of any partial assignment such approval is to have the effect of segregating the assigned portion into a separate lease, the same to continue in full force and effect for the term of the original lease and for not less than 2 years after the date of discovery of oil or gas in paying quantities upon any other portion of the land originally embraced in the lease.

A similar bill has been introduced in the House of Representatives by Mr. Fernandez known as House Bill 3711; the principal difference in the bills being that the house bill provides that all leases issued are to provide for a flat royalty rate of 12½ per cent, which is highly desirable, and should be provided for if possible.

In conclusion may I say that these acts obviously are designed to cure some of the objections that I have endeavored to point out to the Mineral Leasing Act as it now exists and are steps in the right direction, and the passage of them undoubtedly would encourage to a great extent the further exploration and development of the public domain. There are, however, some very harsh and inequitable situations brought about by the provisions of the act as it now exists that the proposed bills do not remedy and consideration should be given to amending the bills also to take care of these situations. The cases I have reference to are briefly these:

First: The bills do not propose to amend the existing act regarding the renewal of 20-year leases issued as a reward for the discovery of valuable deposits of oil and gas pursuant to the terms of permits. I have already pointed out that the existing law provides that these leases may be renewed for successive periods of 10 years "upon such reasonable terms and conditions as may be prescribed by the Secretary of the Interior, unless otherwise provided by law at the time of the expiration of such periods." Many of these leases issued under the old permit system are now beginning to expire and in some instances recent new discoveries of deeper pay horizons have been made and the lease owners are at a loss to know upon what terms and conditions they may be permitted to renew their leases when they expire. To relieve this uncertainty the proposed bill should be amended to grant to any such lease owner the absolute right to renew such leases for a term of 10 years and so long thereafter as oil or gas is produced in paying quantities.

Second: Sec. 2 (a) of the amendment of August 21, 1935, authorized the Secretary of the Interior to allow owners of leases outstanding as of the date of the passage of the amendment to exchange such leases for the new form of lease prescribed by the act. The purpose of this provision was obviously to permit the owners of 20-year leases issued as a reward for the discovery of valuable deposits of oil or gas pursuant to permits to obtain the benefits of the new form of lease authorized by the amendment of August 21, 1935. In many instances discoveries were made on permits prior to the date of the amendment but leases were not actually issued until after the amendment became effective and by the arbitrary date fixed in the amendment these lease owners were not permitted to take advantage of the provisions of the act. Furthermore, the Secretary of the Interior, has construed this provision to be discretionary and under the present rulings of the Department of the Interior exchanges are not permitted where the exchange will result in a royalty reduction to the United States of more than 20 per cent. The present bill should be amended to give the absolute right to all lease owners owning these old leases issued under the permit system to exchange them for the new form of lease regardless of the date when issued and regardless of the reduction of royalty to the United States.

Third: No provision is made in the proposed bills to do away with or to prohibit the further extension of the regulations that have been referred to, limiting the amount of overriding royalties and obligations payable out of production that may be created by any lease owners. Regulations of the Secretary dictating to lease owners the manner in which they should handle or dispose of their working interest oil and gas should be absolutely forbidden. ★ ★ ★

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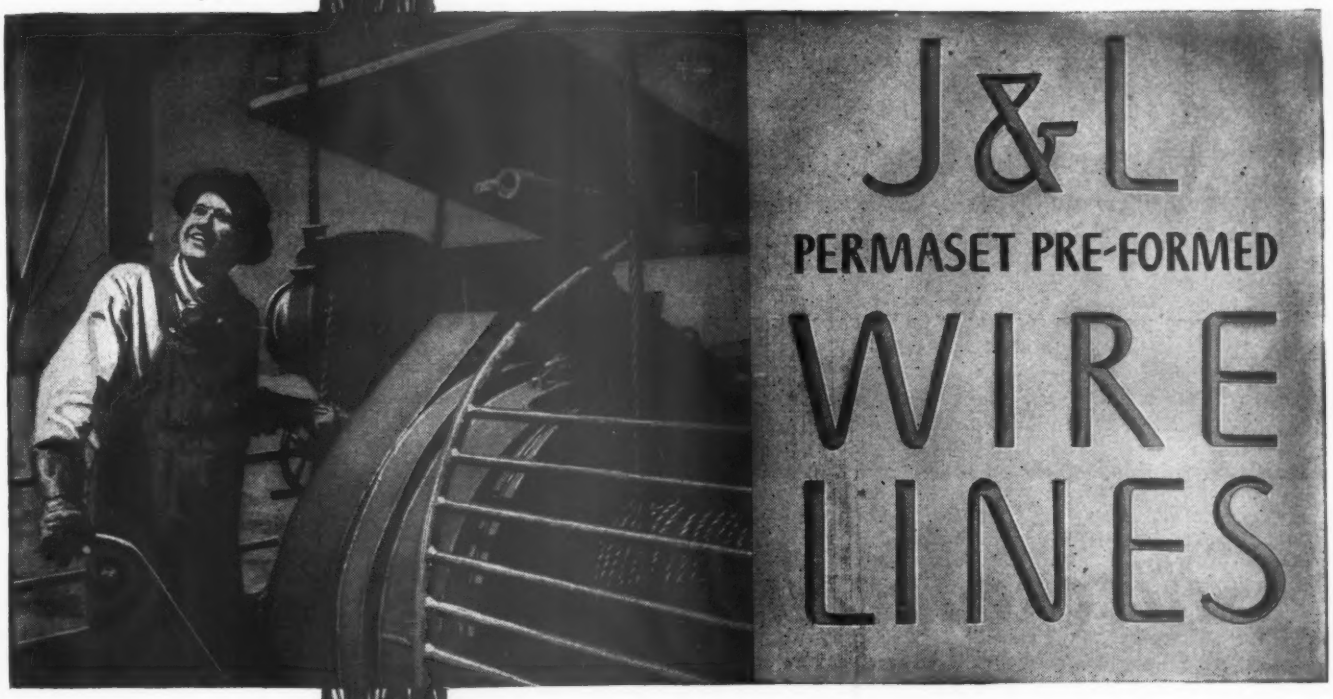

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FIG. 1. Comparison of silicone varnish and high grade organic varnish on test panels under the following conditions; A, silicone unaged; B, organic unaged; C, silicone aged 2½ hr. at 250°C., and bent around a ⅛-in. diameter mandrel; D, organic aged 2½ hr. at 250°C. and bent around a ⅛-in. diameter mandrel; E, silicone aged 200 hr. at 250°C. and still in good condition whereas the organic varnish deteriorated and was badly damaged after but 2½ hr.

Silicone resins

RAISE INSULATION OPERATING TEMPERATURE LIMITS

R. F. HORRELL, *Design Engineer*

Westinghouse Electric Corporation

APPLYING silicone resins to insulating materials makes possible a weight reduction of 50 per cent in certain general purpose industrial motors. These resins, when used in combination with inorganic insulating substances such as mica, asbestos, and Fiberglas, produce materials that have a higher thermal endurance than the conventional materials in use today because these are restricted by temperature limits set by The American Institute of Electrical Engineers Standards No. 1. These temperatures are based on the thermal endurance of the conventional materials and such endurance becomes the primary basis for establishing general machine ratings. Therefore, any development that greatly improves the thermal endurance of insulation is of real importance to the user of industrial motor equipment. There are, however, frequently other design considerations that outweigh thermal endurance so that on some equipment little advantage can be gained. Each application must, therefore, be analyzed carefully by the design engineer.

"What is silicone?" and "In what form is it available?" Silicone is a generic name applied to a considerable group of semi-inorganic compounds that link the organic and inorganic materials. Several of these silicone compounds are resins resembling organic varnish resins in their physical characteristics. The molecule of the silicone resins has an inorganic structure, a silicon-oxygen chain, so that the resins have tremendously greater thermal endurance than the best of the conventional organic resins. Many combinations of molecular structures are possible with these silicone materials, and they may serve numerous purposes. For example, they are used as insulating varnishes, insulating resins, lubricating greases, filling compounds and fluids for various applications.

A complete line of insulating materials incorporating silicone resins with various organic base substances has been developed.

Silicone varnishes are available in forms similar to those with which the industrial motor user is familiar. Some silicone varnishes are made with organic solvents; others are of the solventless type. They are used to impregnate and dip-coat coils, insulation, and wound equipment by processes similar to those in which organic varnishes are used. Silicone varnishes normally require higher baking temperatures than do organic materials, usually 225°C. to 275°C. For this reason, it is essential that a very minimum of organic material be contained in the insulation at the time of the high temperature bake. Therefore, organic resins must not be used in the manufacture of composite insulation to be used in conjunction with silicone varnishes.

If the design engineer is to attain the maximum utility of the thermal endurance of the silicone resins, both surface and sub-surface insulation must be thermally stable and moisture-proof. A complete line of insulating materials incorporating silicone resins with various inorganic base substances such as mica, glass, and asbestos has been developed, with limited availability. These materials are available in the same forms as the more familiar Class B materials and a list of them is shown in Table 1.

Small induction motor stators have been wound with silicone bonded glass-mica slot cells; with silicone varnished glass-covered wire for the coils; and with silicone bonded glass-mica phase insulation. The completed stator was then vacuum impregnated in the high-temperature silicone varnish to provide the waterproof external coating.

The field coils of small direct-current motors have been wound with glass covered silicone treated wire and given a vacuum impregnation and two dips before being placed on the pole pieces. These same materials were used in the armatures, but baking temperatures were

lowered to 200°C. because the solders now available are likely to flow at 250° C. Still other silicone materials have been used in larger machines where pre-insulated and formed coils are used. For example: Silicone bonded glass-mica tape has been used for ground insulation; silicone sized glass tape has been used for the outer protective wrapping; coils have been impregnated with silicone varnish; and the completed armature or field given a final dip and bake in silicone varnish.

The superiority of silicone varnished glass cloth as compared with a Standard Class B varnished cloth after 24 hr. at 250°C. has been demonstrated. The silicone treated cloth retains its original flexibility; whereas the Class B material is severely darkened and embrittled in addition to losing its desirable electrical properties after only 2 hr. The panels in Fig. 1 illustrate aging characteristics of silicone and a high grade organic varnish. Samples A and B are unaged panels coated with silicone and an organic varnish respectively. Samples C and D are the same materials after aging two-and-one-half hours at 250°C. These samples were tested in accordance with the American Society for Testing Materials heat endurance test procedure, which specifies bending the panels around a ⅛ in. mandrel through 180 deg. Sample E is silicone varnish aged at 250°C. for 200 hr. and subjected to the same test. While not illustrated, some types of the silicone resin have withstood this test after aging more than 1000 hr. at 250°C.

Further measurement of the behavior of silicone films on aging is shown in the curve of Fig. 2. The per cent elongation to mandrel failure of 2 mil films has been plotted versus the aging time at 275°C, 250°C., 225°C., and 200°C. For comparison, a curve is shown for 2 mil films of an organic varnish used in Class B equipment aged at 200°C. From this data it has been found that in the range from 200°C. the silicone resins rather closely follow the "Ten Degree Rule"; that is, that the life of the resin doubles for each 10°C. drop in temperature. In Table 2, data taken from Fig. 2 illustrate this rule.

Silicone insulating materials offer somewhat more resistance to moisture than the conventional materials, which use organic varnishes. Stripped films were used in the test for determining moisture permeability by clamping them as membranes over the open mouth of Payne permeability cups and measuring the weight loss under a controlled temperature and in a dry atmosphere. Data obtained show that no more water seeps through the unaged films than through the better waterproofing insulating varnishes or soft vulcanized rubber. After aging for 30 days at 200°C. the silicone film has shown a consistent trend toward improvement, whereas organic films cannot be depended upon as they may or may not improve. Tests on complete equipment confirm these findings. On equipment given moisture and thermal cycling tests, the resistance to moisture has improved with time.

Some low viscosity silicone fluids of the lubricant type make excellent water repellents. These fluids prevent water from forming a continuous film on a surface treated therewith. It has even been suggested that paper raincoats could be made; and fishermen regard the fluid as excellent for floating dry flies in fast water.

One very interesting vibration and thermal cycling test was conducted on a group of silicone-insulated and Class B insulated coils. Various methods of insulating were incorporated. Coils tested used materials such as mica tape, glass and asbestos wire covering with various types of mica wrapper, and glass and asbestos finishing tape. One of the groups of coils was made up of silicone-treated glass-covered wire, silicone-bonded glass and mica wrapper, and silicone-sized tape with silicone treatment applied to the completed coil. These va-

(Continued on Page 211)

TABLE 1

Available forms of silicone resin insulation.

Item	Size	Use
Silicone-varnished glass cloth	Continuous rolls 18 in. wide .004 in. and .017 in. thick	Backing or composite
Silicone-glass-mica wrapper	Sheets 18 in. x 36 in. x .008 in. and .010 in. thick	Coil wrapping
Silicone-glass-mica glass material	Sheets 18 in. x 36 in. x .023	Slot cell liners
Silicone-glass-mica wrapper	Sheets 18 in. x 36 in. x 0.15 in.	Phase insulation in stators
Silicone-varnished glass-covered wire	All standard sizes	Magnet and stator winding
Silicone-filling cement		Plastic filling cement, not rigid
Silicone-bonded glass-mica tape	All standard widths. Thickness—.0055 in. and .0075 in.	Ground insulation for coils
Silicone-sized glass tape	Widths up to 1 in. Thickness up to .015 in.	Protective outer wrapping for coils
Silicone-sized asbestos cloth	Sheets 36 in. x 36 in. x .035 in.	Cushioning material

TABLE 2

Failure time (hours) of silicone insulation.

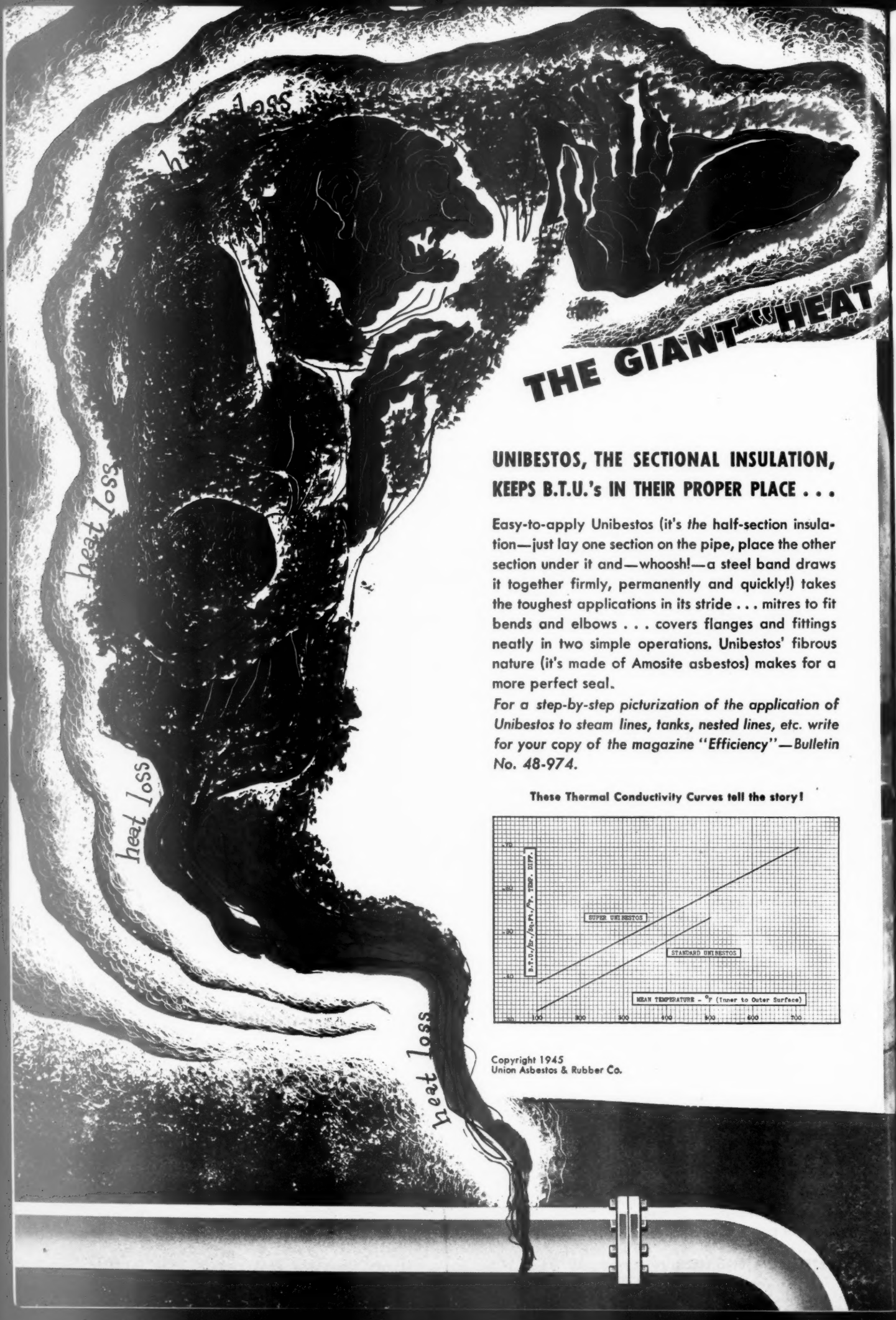
Aging temperature, °C	Elongation of test sample				Craze failure time
	14.4%	7.2%	3.6%	1.8%	
250	36	55	63	80	85
225*	225	290	375	500	590
225**	205	314	360	456	485
200*	1060	1630	.....	.....	.....
200**	1160	1790	.....	.....	.....

*Actual.
**Calculated by 10-degree rule.

TABLE 3

Suggested applications for silicone insulated motors.

Reduced wt. per hp. by operating at higher temperature with no sacrifice in life	Increased life of insulation while maintaining conventional size, weight, and temperature rise	Operating in high ambient temperatures
Rapid reversing motors	Loaders drills, shuttle cars, coal cutter motors, etc., in mining applications	Furnace motors
Fan-cooled motors		Roll table motors
Variable voltage drives where ventilating is reduced at low speeds with normal current in windings	Motors for creamery applications where humidity is high	Ventilating fans
Machine tool motors where space is limited	Motors handling fluctuating loads with high peaks	Circulating fans handling hot gases
Submarine propulsion motors	Motors operating in caustic and acid fumes	Dry kiln motors
Marine motors where saving in weight and space are important	Pickling, cleaning and plating lines	Copper mining application, such as scraper hoists
Some hoist applications	Motors used in tropical locations with high humidity	Cooling tower motors (high humidity and ambient)
Crane motors		Open hearth department
Wood working where motors are shell type or built-in		Bessemer converters forced draft blowers in marine boiler rooms
Short-time rated motors with extremely limited weight and space conditions		Boiler room auxiliaries on shipboard; that is, oil burner motors, oil pump motors, etc.



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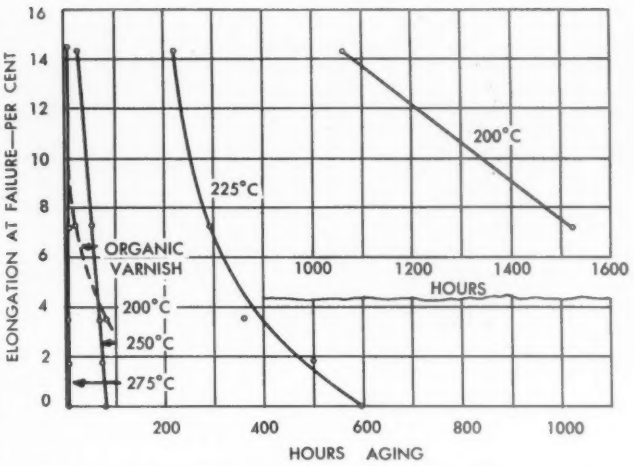


FIG. 2. Comparison by elongation of silicone varnish film .002 in. thick and organic varnish film .002 in. thick after thermal aging.

FIG. 3. Bearing failure rather than insulation deterioration ended the 3376-hr. test of this motor operating at 250°C. hot-spot temperature. Even molten metal caused little insulation damage.

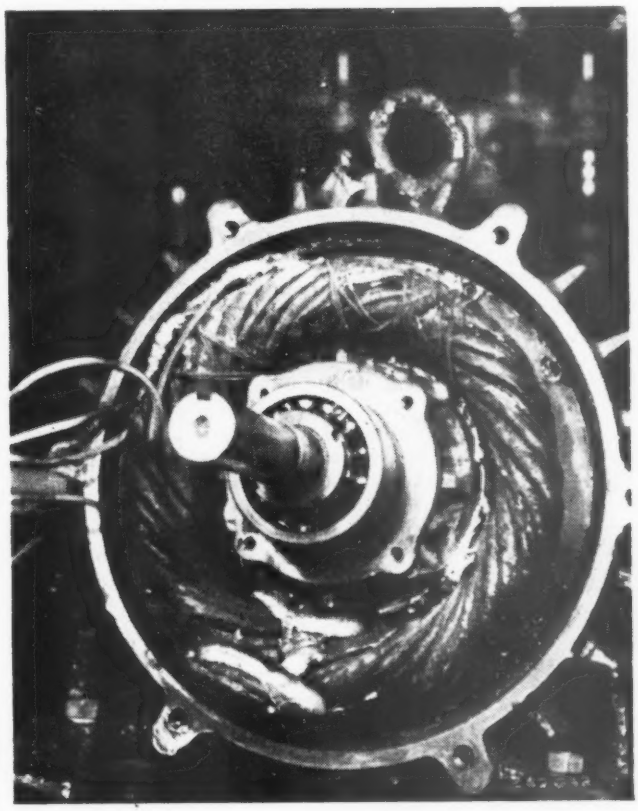
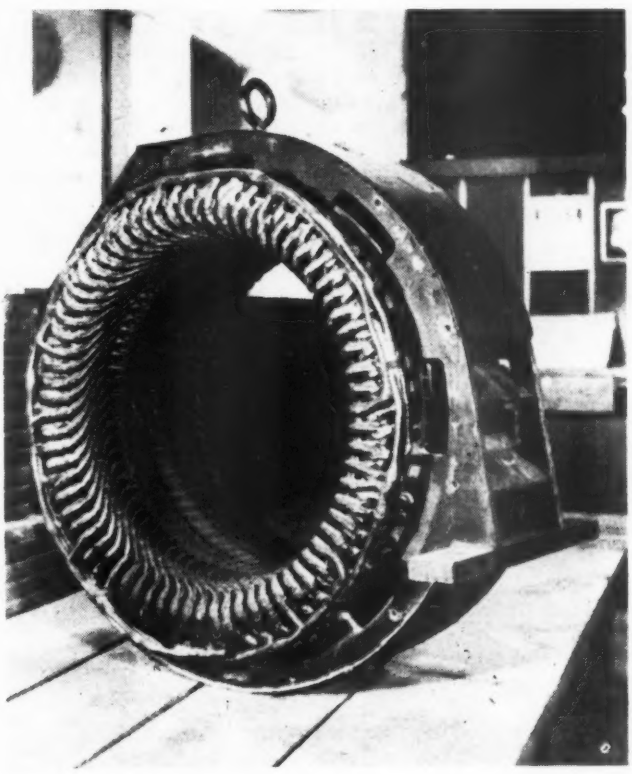


FIG. 4. Comparison of silicone varnish and high grade organic varnish on magnet coils under following conditions: left to right, Class A insulation aged 200 hr.; Class B insulation aged 2750 hr.; HTS insulation aged 5000 hr. All at 235°C. as observed by resistance.

FIG. 5. After 2966 hr. of operation at an estimated hot-spot temperature of 250°C., the HTS insulation on this 250-kva., 440-volt generator was still in satisfactory and usable condition.



(Continued from Page 207)

rious coils were placed in a 28-in. diam. d-c. motor armature with a 28-in. core length for convenience only. The armature remained static and was vibrated by external means. Severe thermal cycling was obtained by supplying 750 amp., 420 v., a-c., 72 times per min. This load was intermittent and was held for 3 sec. duration. During this test, temperatures in the order of 230°C. were observed. The tests covered 16 hr. per day for a period of 36 days. Examination of the test coils revealed that while some of the Class B insulated coils had not failed, they showed signs of thermal aging and embrittlement of the resins. The silicone coils not only withstood the test satisfactorily, but the insulation was still in excellent condition.

In order that the life of the silicone insulation be at least equivalent to that now obtained with Class B insulation, it is suggested that the limit for the permissible observable temperature by resistance be set 40°C. above the present Class B limits. This general rule is offered because certain types of equipment have special temperature limits for Class B insulation. It is proposed that the general limit corresponding to AIEE Standards No. 1 be 175°C. for hot spot temperature. This includes a 5°C. increase in the allowable difference between the observed value and the hot spot temperature.

There are three important ways in which improved thermal endurance properties may be utilized by design and application engineers in the industrial field. They are:

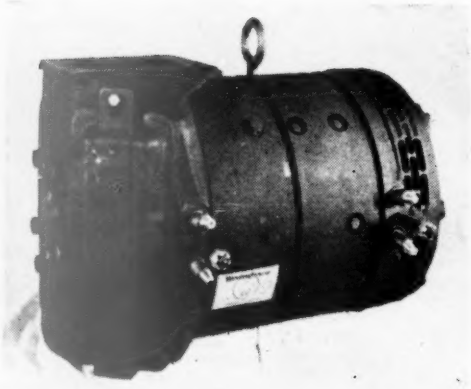


FIG. 6. ***Left*****—Silicone insulated traction motor for PCC street car.**

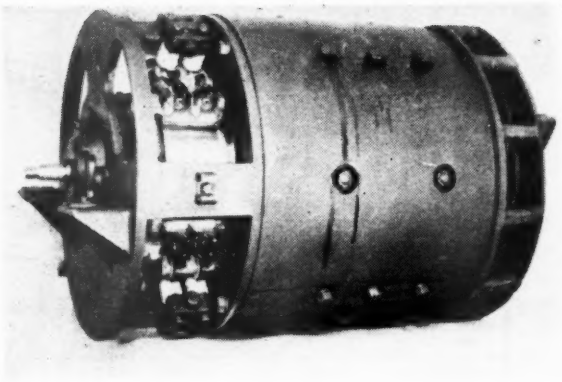


FIG. 7. ***Right*****—Silicone insulated drive motor for a single motor trolley coach.**

1. *A reduction in size and weight of electrical equipment is possible where the operating temperature can be increased and where no reduction in insulation life can be tolerated.*
2. *Increased service-life of the insulation can be obtained where it is desirable to maintain conventional size, weight, and temperature limits.*
3. *Operation in ambient temperatures above the permissible limits for conventional types of insulation can be maintained.*

All the applications to which silicone resins and composite insulation have been introduced is beyond the scope of this article. Here are a few typical examples of their use in various equipment at the present time:

1. Totally-enclosed fan-cooled induction motors.

(a) Early in 1942 a totally-enclosed fan-cooled induction motor stator was wound for 10 hp. using the best available Class B insulating materials. This stator was given a vacuum impregnation and two dips in silicone resin varnish. The motor was normally rated 3 hp. with Class A insulation and 5 hp. with Class B. A series of engineering tests, including overload temperature runs, were made. The overload runs included a 13-hr. test at 300°C. total operating temperature, and a peak overload test during which 500°C. total temperature on the winding was observed by thermocouple. These tests were followed by an accelerated life test on the insulation during which the motor winding was operated at 210°C. rise by resistance (250° C. hot-spot temperature) for 3376 hr. The motor was dismantled and examined periodically. The winding was also subjected to a high humidity test. The test was terminated by a bearing failure that resulted in damage to the winding. Fig. 3 shows the failure that resulted in molten aluminum running over the winding with little damage to the winding.

(b) A second motor was rated 25 hp. at 1750 r.p.m. and was built in a 15 hp. frame. The motor was insulated as in (a) above. This motor ran for over 3200 hr. at 250°C. hot spot before a mechanical failure of the bearing stopped test.

(c) A third motor was built the same as (a) above except that silicone materials were used throughout. This motor is still driving a M-G set after completing over 4100 hr. at 185°C. hot spot temperature. The set is shut down frequently so that in all respects the motor receives actual service.

(d) Another example is a 7½-hp. motor that drives a caustic pump in a moist atmosphere. This motor operates 24 hr. a day and is started once a week. It has been in service for over 11 months as against only a little over 5 months for a Class A insulated motor.

(e) A fifth motor rated 25 hp. drives an evaporator pump in a wet location. This motor has been in operation for over 13 months, whereas previous conventionally insulated motors failed in approximately 6 months.

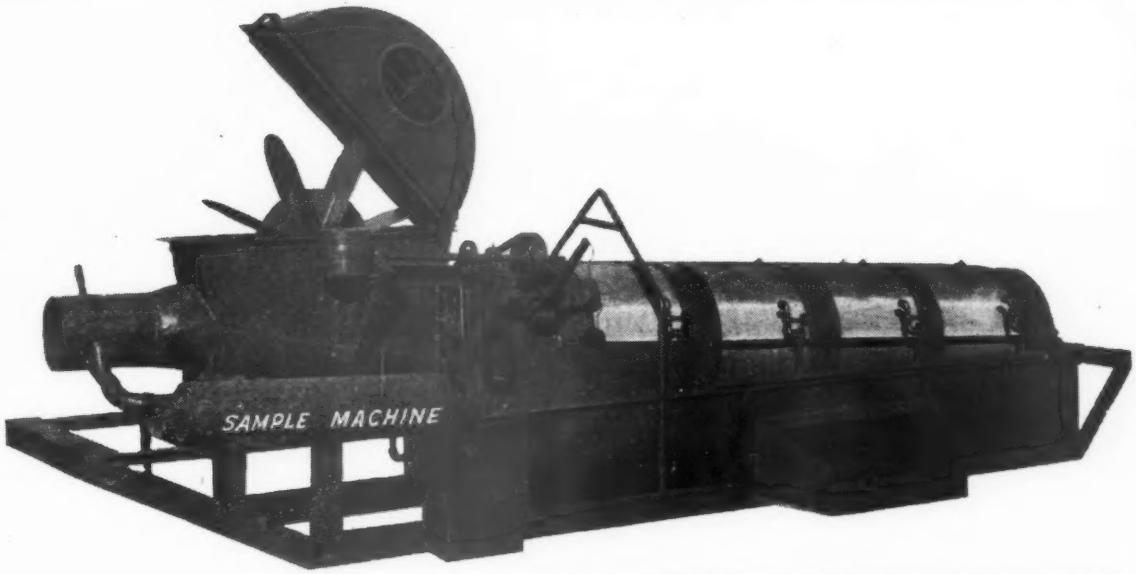
2. One 250-kva, 440-volt generator was made with silicone insulation throughout the stator. As a preliminary temperature test, the stator was short-circuited at 275 per cent normal current. This load resulted in an observed temperature of 355°C., which was held for 6 hr. Subsequently, the stator was redipped and baked and then subjected to an accelerated thermal aging test. The test consisted of heating the stator on alternate days by loading the unit as a generator. The observed rise by resistance was 210°C. (250°C. hot spot). At the end of 2966 hr. the test was terminated even though the insulation was still in satisfactory condition.

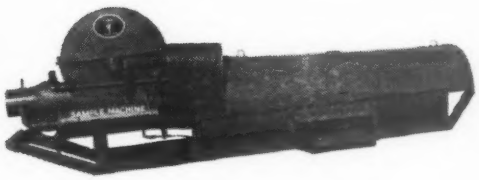
3. A few mining locomotive motors, street railway motors, and trolley coach motors have been made with silicone materials and are now being tested in the field. Some have already given service far beyond that obtained with conventional materials.

4. Magnet coils for relays and contactors, and several hundred dry type transformers have been insulated with silicone materials and placed in service.

The foregoing applications are typical of the ways in which the high thermal endurance properties of silicone resins and materials can be applied to industrial equipment. Table 3 suggests others. It will be noted that some applications overlap. Also, that some applications must be carefully studied to insure proper results. For instance, on machine tool motors care must be exercised to

FIG. 8. Despite the difference in size, these two motors each produce 10 hp. at 1750 r.p.m. The smaller has HTS insulation and weighs 210 lb.; the larger has Class A insulation, weighs 410 lb.





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insure that the higher temperatures involved will not affect the accuracy of machining. Another precaution to be taken is one that of keeping the bearing temperatures at safe operating temperatures. The safe temperature for grease lubricated bearings is 110°C. total temperature if the proper lubricant is used. It may be necessary to provide cooling for the bearings on some machines applied in a high ambient.

It must not be assumed that silicone insulation is a cure-all for motor ills. While an excellent insulating material, it must be applied with extreme care if maximum utilization of its properties is to be realized. As more and more equipment becomes available for handling the manufacturing processes, then, and only then, can there be extensive use of silicone motors.

To evaluate completely the possible advantages to be realized by using the increased operating temperature silicone offers, certain characteristics must be considered. The following study is based on increasing temperature only, the speeds and insulation allowances being conventional. It should be remembered that other problems are introduced, particularly mechanical problems as previously mentioned. Obviously, these problems can be solved only by experience on specific applications. Other considerations relate to performance — efficiency and power factor. In other words, it should be recognized that the major advantages derived from silicone insulation are accomplished only through a balanced design.

1. Small industrial motors: Most designs in commercial production are Class A, 40°C, rise machines. Some weight reduction would be possible on certain designs in going to 50° C. rise without change insulation. Further weight reductions would be possible on some of these by using conventional Class B insuation. On some motors, such as the open and splash-proof types, the torques, efficiency, and power factor requirements limit the advantages to be gained by use of the high-temperature insulation. On some totally enclosed fan-cooled motors the same factors may well apply. However, there may be more possibilities in redesign for weight reduction because the operating temperature, frequently the limit in design, has been increased.

2. Large synchronous and induction motors: The larger machines and higher speed machines could in some cases be reduced in weight by utilizing fully the present Class B temperature limits. In addition, there are some of those larger or higher speed designs that could be made still smaller, if an increase of 40°C. were possible above present Class B limits. In most cases, the maximum possible gain in size and weight reduction through increase in permissible temperature will require some sacrifice in efficiency, and power factor on induction machines.

3. Large direct-current machines: The effect of temperature on size and rating of this class of equipment depends upon the design characteristics, particularly on the ratio of copper loss to iron loss. Their design is standardized through establishment of lines of frame sizes to fit widely varying conditions. This naturally results in some machines being larger and heavier than those specifically made to suit a particular application.

As fibrous glass was introduced to various industries, new hopes were held for higher operating temperatures, but suitable treating materials were not available. Now, with silicone resins indicating that the desired results can be achieved, both in the laboratory and in the field, extensive use of high temperature silicone insulation can be expected. Many types of electrical machines are larger and heavier than need be if high temperature silicone insulation is used. In some instances it may be desirable to supply renewal parts treated with silicone for existing equipment that has a short life or requires increased power. Because silicone processes and materials are still relatively new and requires additional development the cost of the silicone insulated machine is necessarily higher than the more conventional types. In any event, the new silicone materials must not be considered as the cure-all for all insulation problems, but must be applied with caution and vision on specific applications where their use can be justified.

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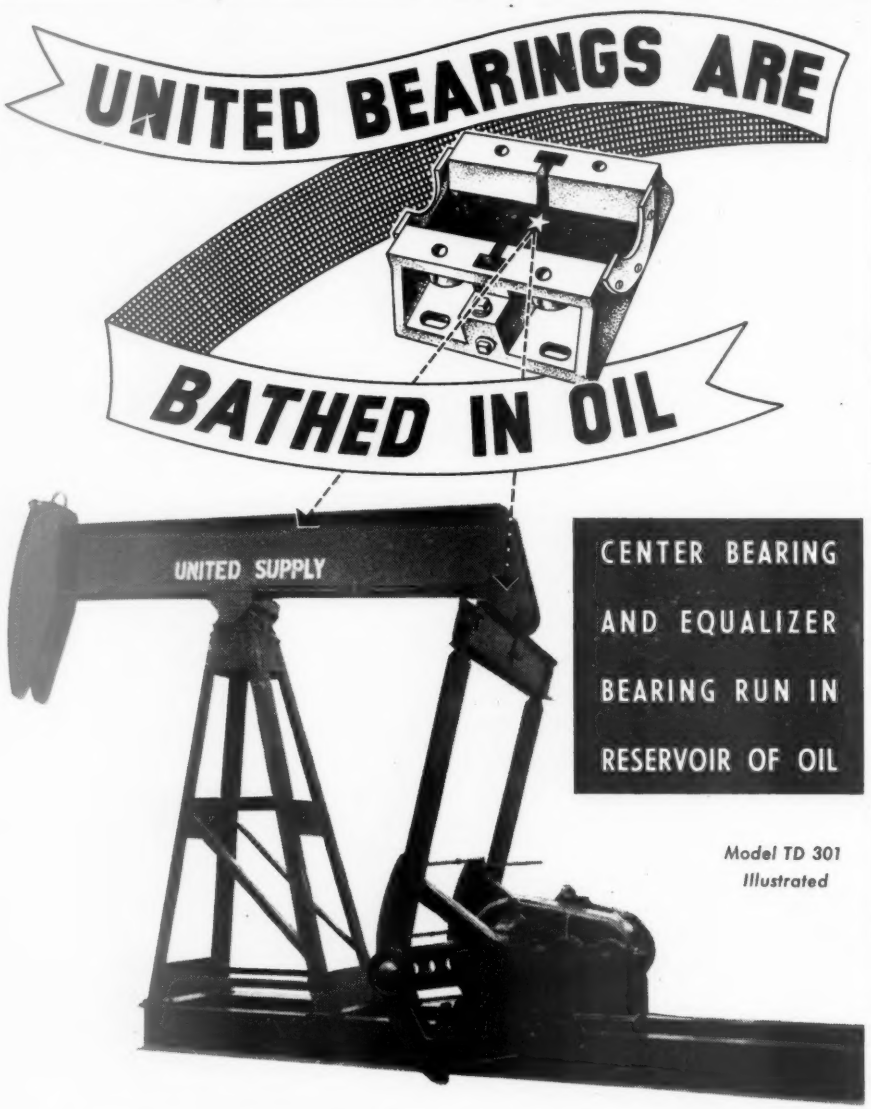

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1. **Pump and driver are built,** assembled in perfect alignment, and tested at one factory. There is no compromise to efficient performance, no mismatching of elements.
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3. **One guarantee covers** the whole. Fairbanks-Morse guarantees the pump, the motor, and their combined performance.

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H. G. Botset, Gulf Research Laboratory physicist, points out features of the electrolytic model oil field, which he developed for planning oil production operations, to Miss Dorothy Hardic, engineering assistant.

MINIATURE OIL FIELD FORETELLS PRODUCTION

An electrically-operated miniature oil field, which will save immense quantities of oil that otherwise would be lost beneath the earth's surface, has been perfected by Gulf Oil Corporation.

The new device will substantially increase the world's usable oil resources, by assuring a greater percentage of oil recovery.

By an ingenious process, the miniature field foretells with considerable accuracy just what will happen in an oil producing area for periods up to 20 years in the future.

From such forecasts, oil production may be planned so as to force to the surface a greater percentage of the oil reserves hidden in the earth than was previously practical.

The "Electrolytic Model Oil Field," as the instrument is christened, was pioneered by scientists of Gulf Oil Corporation's research laboratory at Harmarville, Pennsylvania.

Already in practical use, it is making possible greater oil production from existing fields, as well as contributing to economy of the work.

Maximum oil extraction is achieved by the electrolytic model's ability to gage how water flooding or gas injection operations may be conducted without isolating part of the oil reserve so that it does not flow to the surface.

The accomplishment of the Gulf scientists, who developed the model, lies in their adapting to practical use the laws of physics by which a current of electricity will travel through a sensitized material in a manner similar to a fluid flowing through a porous material.

Thus they can measure by electric current how water and gas injection operations will work out in particular fields, and how they may be modified for best results.

Here is how the model works: Miniature "wells"—actually small plastic tubes with hollow tips piercing a sensitized mat—are arranged in the same relation and at proportionate distances as in a given oil field.

The tubes representing output wells, through which crude oil or oil-bearing gas flows to the surface in the real field, are filled with colorless liquid. Those representing input wells, into which water or dry gas is pumped, contain a blue liquid.

The sensitized mat to which they are connected is made of gelatin. As set in the model, the mat is not directly visible to the operator, but he views it through a mirror. A camera attachment also records the progress of the forecast operations at close intervals.

ALCO ACQUIRES BEAUMONT IRON WORKS

ALCO-Engineered Equipment Now Available for all phases of the Oil Industry

ALCO PRODUCTS' postwar manufacturing and service set-up for the Oil Industry has been advanced with the acquisition of Beaumont Iron Works.

This merger brings to the oil industry the advantages of being able to buy drilling, producing and refining equipment from a single dependable source.

The high standards always associated with ALCO Heat Exchangers, Pressure Vessels and Prefabricated Piping, and with Beaumont Oil-Well-Drilling and Production Equipment, will be firmly maintained by the present Beaumont and Alco management and personnel.

Jones & Laughlin Supply Company will continue as exclusive stock distributor of the Beaumont line.

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- Heat Exchangers
- Steam-Generating Equipment
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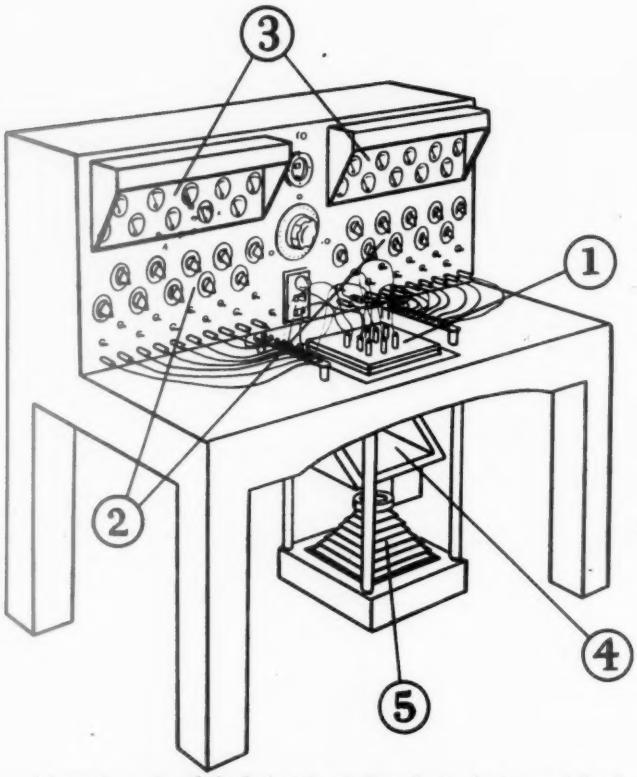

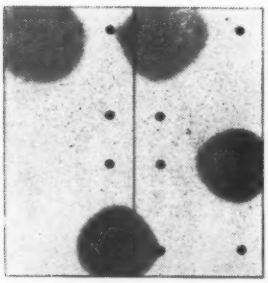

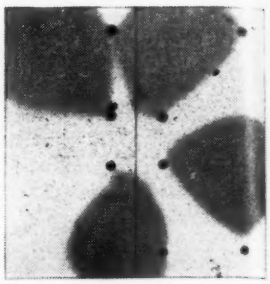

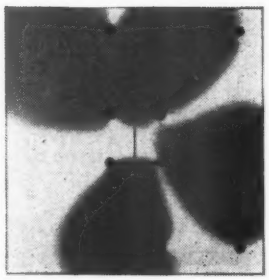

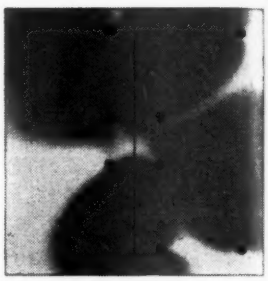

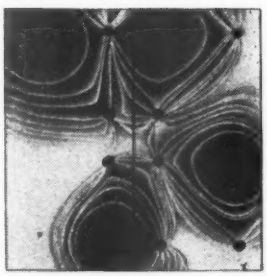

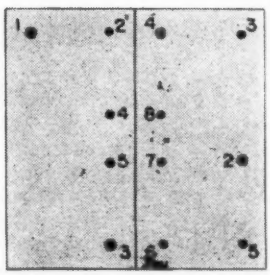

Above is a simplified sketch of the electrolytic model oil field to show how it works. 1—plastic tubes representing input or output wells; 2—control knobs to adjust flow, in or out, for each well; 3—dials to measure flow; 4—tilted mirror by which operator can view progress of flow pattern, and 5—camera to record flow in pictures. Right, spread of fluid through oil sands reproduced on model. Four upper photos show spread of water from injection toward producing wells (black dots). Left bottom photo tells same story in one composite picture. Bottom right shows field before flooding began.

Two types of operation may be simulated. One is water flooding, in which water pumped through intake wells forces the crude oil toward and up through the output wells.

The other type represents cycling in condensate fields. Here oil-bearing gas drawn from the wells is treated to recover the oil. Then the dry gas is pumped back underground to force additional oil-bearing gas toward the surface and to maintain pressure sufficient to prevent the oil from dropping out of solution and being permanently lost in the sands. On the electrolytic model one process in effect "duplicates" both these operations.

Current, exactly measured by meter and susceptible of alteration by panel dials of the model, is fed through the intake "wells" into the sensitized gelatin mat, turning the gelatin blue as far as it penetrates.

The blue field so created fans out from the input wells towards the tip of the tubes indicating output wells. A color pattern is thereby formed of the flow, showing how dry gas will force wet gas or water will force oil, toward the producing wells. As the pattern progresses, it shows the point at which one or more output wells are blocked off or rendered inaccessible to portions of the oil sands.

The different stages of flooding are exactly recorded by photograph as well as visually.

It now become the job of the operator to obtain a flow pattern nearest to ideal for forcing all available crude or oil-bearing gas to the surface without causing loss of any of the available supply beneath the field. This he approaches by controlling the rate and volume of current fed in, and by setting up new input or output wells and neutralizing others.

In a short period he can develop the pattern promising maximum output with minimum loss.

Once the ideal operation is worked out on the model, it can be translated directly to action in the field, for the rate of flow and volume of current can be transposed accurately into terms of fluid fed into the actual input wells. The sinking of new input or output wells or neutralization of others is also undertaken as a result of the experimental arrangement that worked best on the model.

Actually the model offers the oil operator an opportunity to plan his work on the same basis as though he could actually experiment in a particular field for years—and then begin all over when he found the method that produced the best results.

The salient data compiled from the model are: How much oil can be produced from the field, and consequently the most efficient procedure for recovery operations.

For instance, the flow pattern evolved on the model aids in determining the location and number of wells including what wells should be shut off or neutralized, the desirable rate of flow per well, and the amount of water and gas needed.

The whole picture of operations that will give the maximum future yield may be deducted in a few hours, a condition heretofore impossible.

Previously, in the determination of water and gas injection methods, the volume of oil was estimated from porosity and saturation of the sand. Resulting forecasts of the percentage of oil that might be recovered were not always dependable. Neither could location of additional wells be effectively planned.

Studies of gas injection and water flooding on the electrolytic model obviously represent theoretical conditions seldom found in actual practice. Today, however, when scientists temper these results with their information on the geological structure of particular fields, the final deductions show considerably improved accuracy.

The model, which can represent a field of up to 20 wells, is about the size of a home work bench, with an upright instrument panel and with the miniature field set horizontally in the center. In analyzing large areas, the area is divided and handled in sections.

To make a forecast of oil field history for the next score of years takes the model not more than three hours. ★ ★

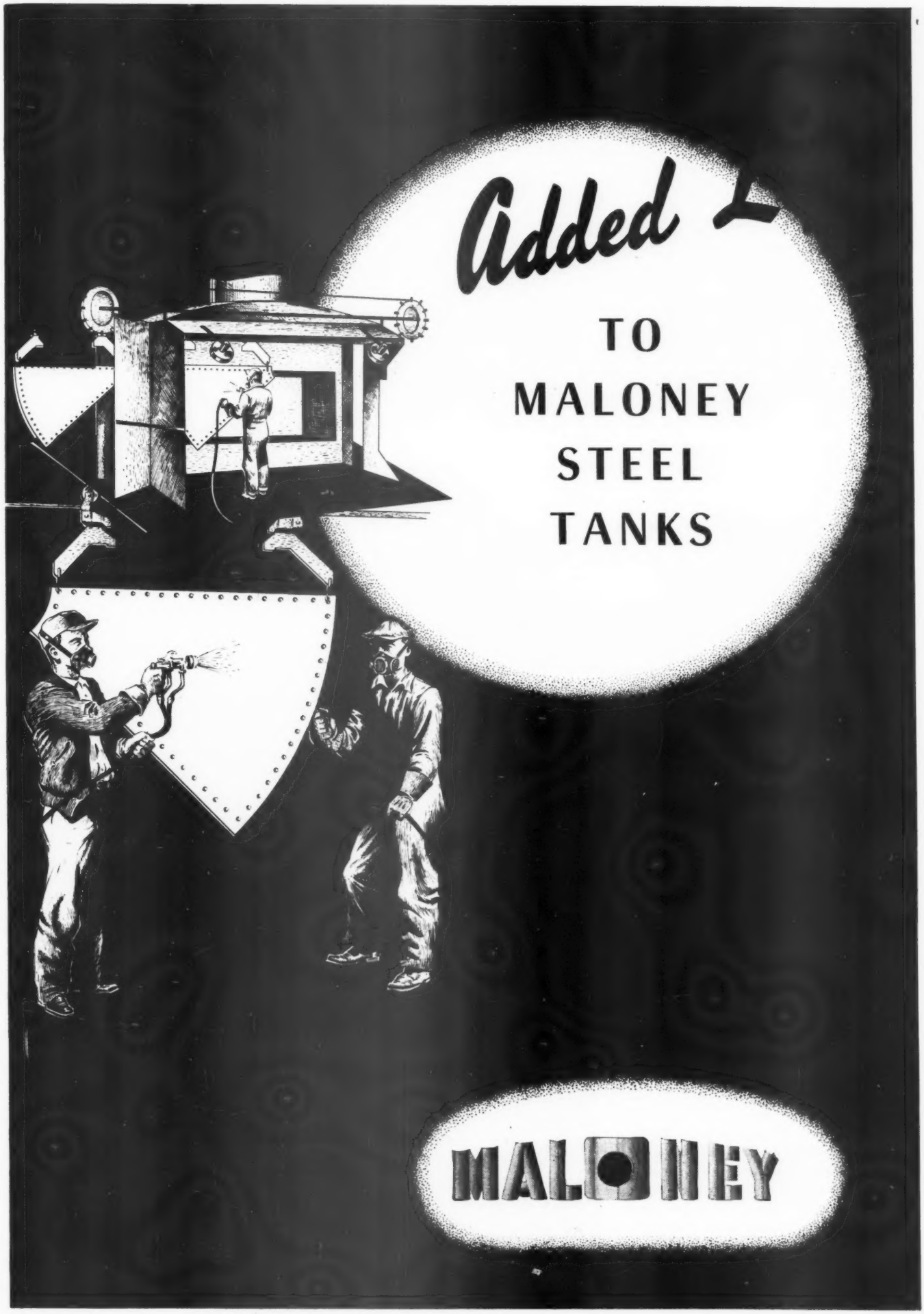
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FIG. 1. Paraffin well servicing unit.

Exclusive

Petroleum Engineer

PICTURE STORY

MOBILE UNIT TO SERVICE PARAFFINED WELLS

By **WILLIAM J. DAVIS**

MARVIN A. SMITH, Kilgore, Texas, has an up-to-date approach to an old problem. A unit that can be moved about the field to service wells with paraffin deposited on the tubing walls. Usually this deposit forms at the cold salt water level of the hole on a flowing well. The unit is mounted on the rear of a ½-ton pick-up truck complete with all necessary tools and rigging, as shown in Fig. 1, above. A 4-hp. gasoline engine drives the No. 10 winch by V-belt drive. An outboard bearing carries an extension of the winch shaft, which has a 9-in. crank welded to it. This gives an 18-in. throw to the spudding attachment used in connection with the winch drum. An ⅛-in. soft-laid steel line is used to lower the tools into the hole. The rear of the pick-up has a frame constructed of old sucker rod upon which scaffold boards can be placed in order to aid the operator in making connections on wells with tall christmas trees.

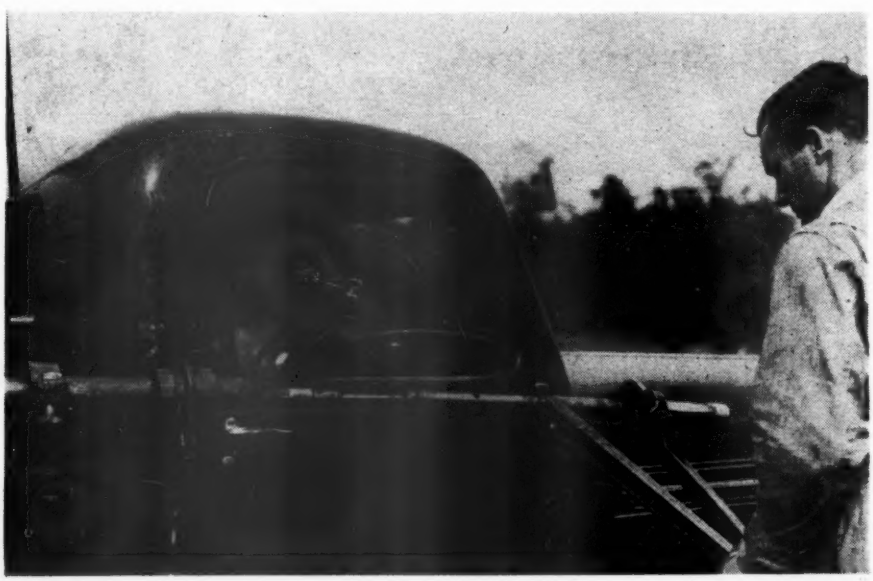

FIG. 2. The tool string is assembled in the oil saver barrel, which is 7 ft. long with gate valve attached. String consists of special rope socket, sinker bar weighing 24 lb., a set of special swivel jars with 7½-in. stroke, and the parraffin cutting tool. A standard swivel head at the closed end of the barrel allows the steel line to enter barrel without oil loss.

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FIG. 3. The unit needs no derrick or gin pole to perform its work and can be rigged at any distance from the christmas tree that accessibility requires. Rigging up time can be completed in less than 15 min. from the time the unit arrives at the well until the tools are ready to be lowered into the hole. The well is under control at all times and can be shut in by the use of the gate valve on the oil saver barrel at the wellhead.

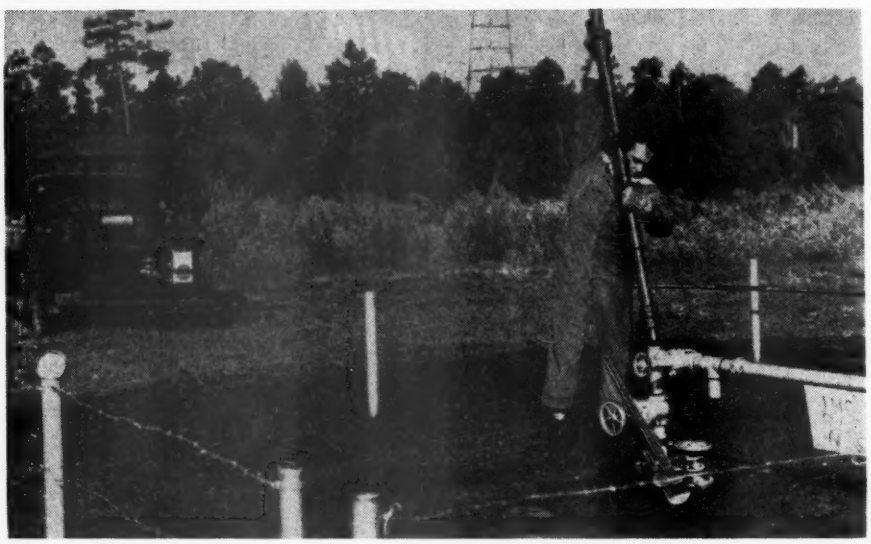


FIG. 4. Step-lugs are welded to the oil saver barrel to allow the operator to adjust the swivel head when rigging up. The entire string of tools weighs 38 lb. when assembled in the oil saver barrel and is carried on a rack made of ½-in. by 1½-in strap iron on the right side of the pick-up when not in use.

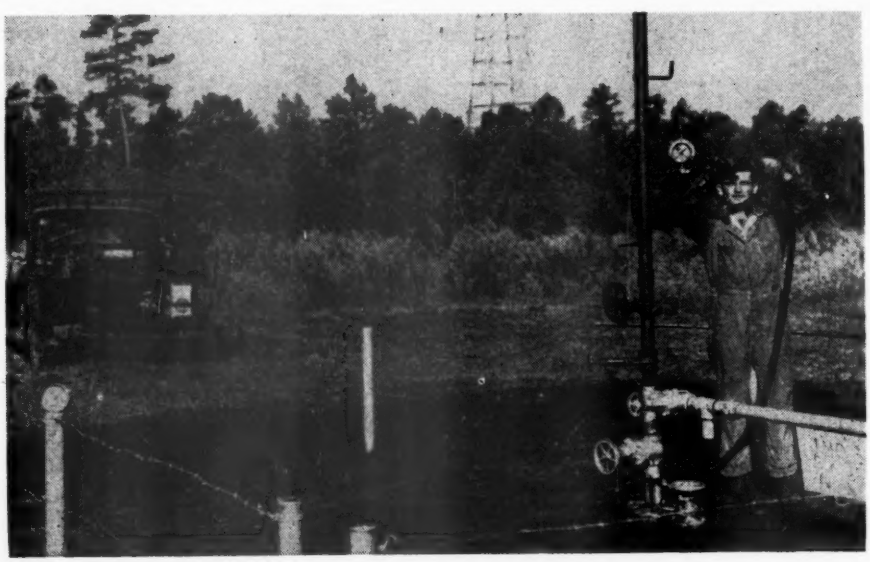


FIG. 5. A ½-in. nipple welded into the oil saver barrel allows pressure gage and 1-in. hose to be attached. The well is cracked just a little during the shaving process and the upward flow of oil carries the dissolved paraffin to the surface where it can be sprayed about the grounds or emptied into a suitable container. A hold-down pulley is attached to the base of the oil saver barrel to change the horizontal torque to a downward pull, relieving oil saver barrel from being pulled over by wire line.

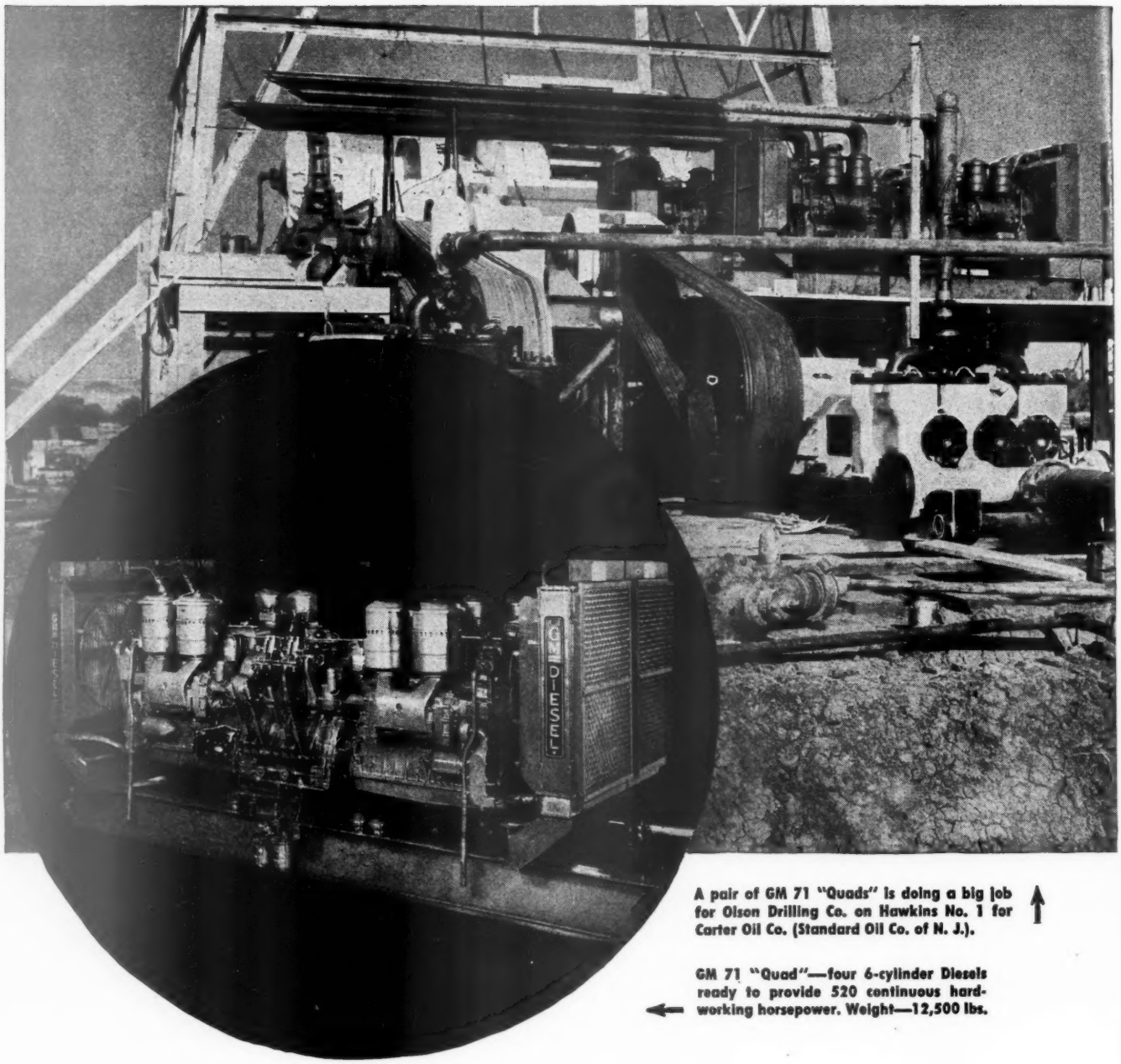
FIG. 6. When operating the unit, there are only two controls used, the winch brake and the lever to the idler pulley that disengages the engine from the winch. The seat is arranged to give a clear field of vision to the christmas tree and access to the unit controls.

FIG. 7. This view shows the seat of swivel jars in the closed position. Holes have been drilled to allow free oil circulation around the jars to prevent sticking during spudding operations.

FIG. 8. The jars are now in the extended position. The action of the sinker bar in closing the jars doubles the effective force on the cutting knife in freeing paraffin.

FIG. 9. Two types of cutting tools that can be used are shown. The spear with the half-twist is run on holes that are badly paraffined in order to force an opening for the shaving tool, or box knife, used on the next run. The box knife can handle the average paraffin job without help of the spear. Cutting tools range in size from 1⅜ in. to 2¼ in. Smith appears in all the views.

The overall producing rate of a flowing well troubled with paraffin in the tubing can be greatly increased at low cost and a minimum of shut-in time, using the method illustrated herewith. The unit combines compactness and utility with speed and efficiency in its design and its operation in the field. ★ ★ ★



A pair of GM 71 "Quads" is doing a big job for Olson Drilling Co. on Hawkins No. 1 for Carter Oil Co. (Standard Oil Co. of N. J.).

GM 71 "Quad"—four 6-cylinder Diesels ready to provide 520 continuous hard-working horsepower. Weight—12,500 lbs.

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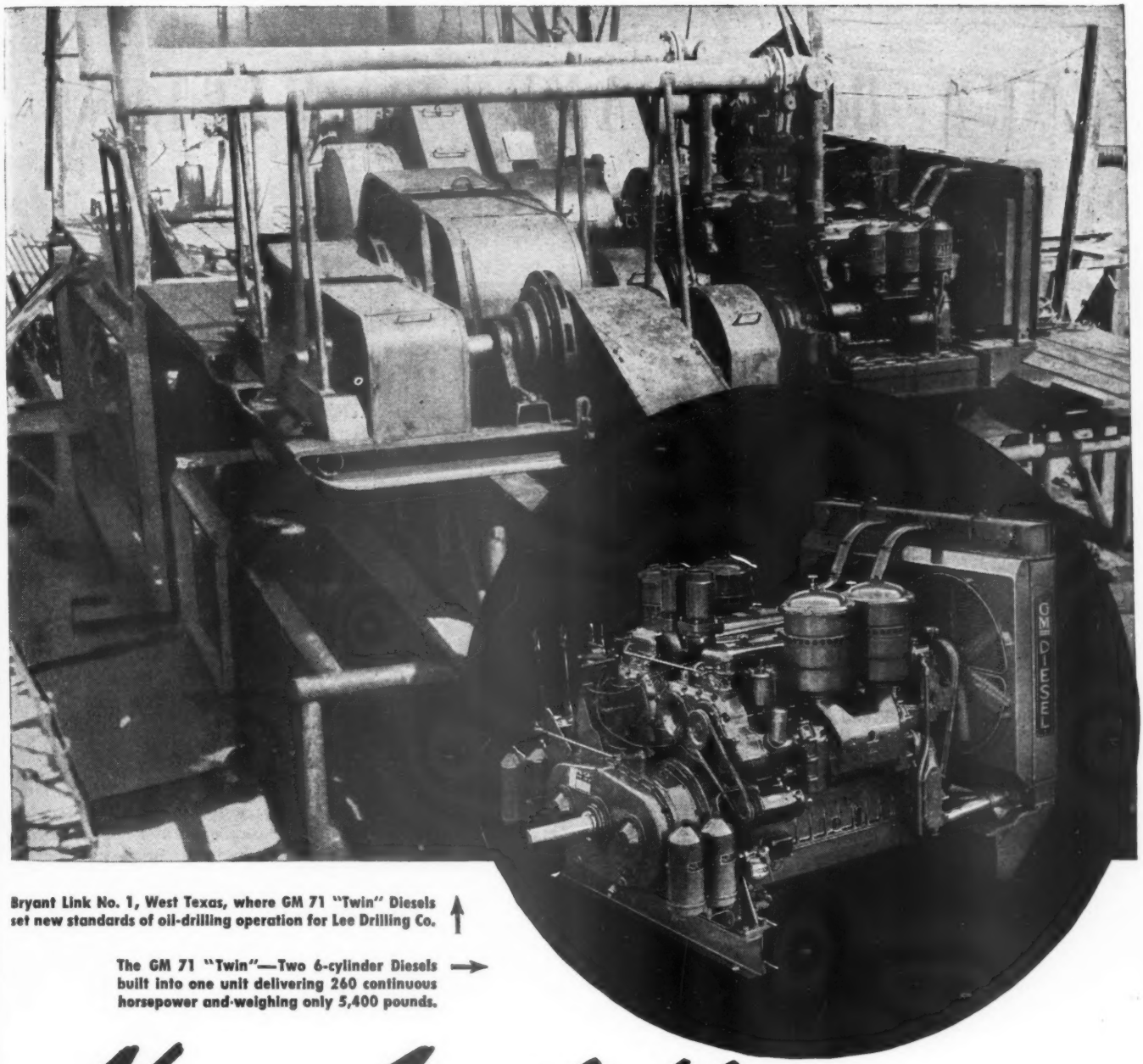
These are the Diesels which have earned an unmatched record for dependability under war's most brutal treatment. Plan now to put this power to work for you.



Bryant Link No. 1, West Texas, where GM 71 "Twin" Diesels set new standards of oil-drilling operation for Lee Drilling Co.

The GM 71 "Twin"—Two 6-cylinder Diesels built into one unit delivering 260 continuous horsepower and weighing only 5,400 pounds.

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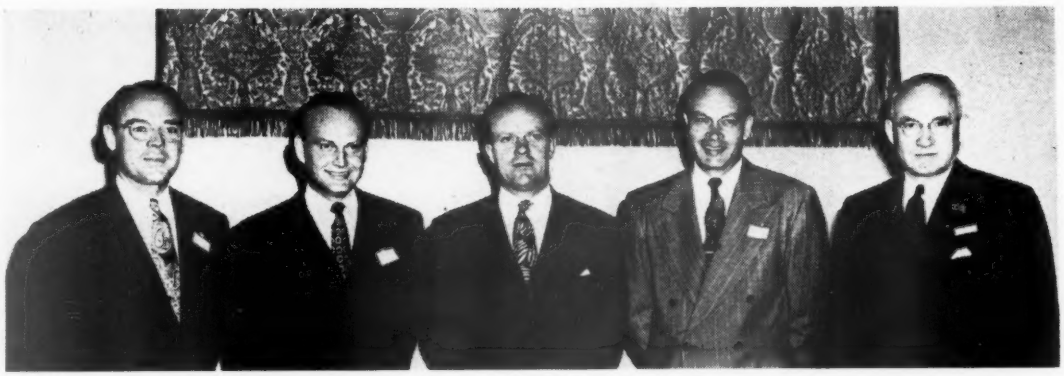
CNGA HOLDS ANNUAL MEETING



SPEAKERS AT MEETING. Left to right: F. D. Parker, consulting engineer; M. M. Perkins, M. W. Kellogg Company; Fred Hartley, Union Oil Company of California; E. W. McAllister, Western Gulf Oil Company; H. A. Gehres, The Cooper-Bessemer Corporation.

THE 20th annual fall meeting of the California Natural Gasoline Association was staged at the Biltmore Hotel, Los Angeles, Friday, October 12, and some six hundred members and friends were on deck to participate in the fine all-day program that had been arranged for the occasion. With morning and afternoon technical sessions and some relaxation in the form of a banquet and floor show in the evening, the day was well filled.

Under the chairmanship of Vice President M. W. "Jim" Kibre, the morning session opened at 10 a. m. with a paper by E. W. McAllister, chief engineer, Western Gulf Oil Company, entitled, "Application of Laboratory Data on Phase Behavior to Evaluation of Condensate Reserves." With a second condensate recovery plant now nearing completion in California, this paper was of especial interest to valuation and design engineers, since it presented methods for the evaluation of reserves and for the prediction of performance in the condensate type of reservoir.

The second paper of the morning was "An Engineer's Viewpoint on the Design of Compressor Cylinders for High Pressure Gas Compressors," delivered by H. A. Gehres, vice president, The Cooper-Bessemer Corporation. It was also appropriate in view of the increasing compression requirements that are daily facing the oil industry. With great advances in both production and refining techniques the trend is toward continuously higher pressures, he said, and it is incumbent on design engineers to accommodate their efforts not only to prevailing conditions, but to prospective requirement.

At the conclusion of the morning session, a special luncheon was given by the officers for the speakers.

Chairman of the afternoon session, which opened at 2 p. m., was W. L. Rifenberick, Industrial Engineers, Inc., who first presented Marion L. Arnold, president of the association, in his annual message. Arnold discussed the various methods by which the CNGA might enlarge its value to the natural gasoline plant operators and to the oil industry generally. In part, he stated, "Concerning the additional services which CNGA can render for industry, I believe that one of the most important would be the promotion of a greater spirit of cooperation between the producing, natural gas, and gasoline, and the refining divisions of the petroleum industry. This can best be accomplished by bringing about a general understanding of the problems of each division and particularly of problems common to two or more divisions. Two problems of this latter type will be mentioned.

"In planning for the production of fields by pressure maintenance or by cycling, close cooperation is required between the engineers of the producing and the natural gasoline divisions to insure the installation at a minimum cost of ample facilities for the production of the field. This requires an understanding by the gas department engineers of the principles of reservoir control and operation. It requires an understanding by the production engineers of the limitations inherent in pipe line systems and absorption and compression plants. The inclusion in our programs of papers such as those presented this morning should do much to advance this understanding.

"A problem common to both natural gasoline and refinery men concerns the most efficient utilization of that portion of our petroleum resources represented by propane and butanes. One of the objectives of the meeting is to further our mutual understanding of this problem. By including on the CNGA program committees, men from the producing and refining divisions, other problems of mutual interest will be disclosed. The discussion of these problems would be in-

OFFICERS OF CALIFORNIA NATURAL GASOLINE ASSOCIATION. M. W. Kibre, General Petroleum Corporation of California, vice-president; M. L. Arnold, Richfield Oil Corporation, president; George F. Howells, Tide Water Associated Oil Company, secretary, Taft Chapter CNGA; George L. Tyler, secretary, CNGA.

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. . . the only 2,000-lb. test, metal sealed

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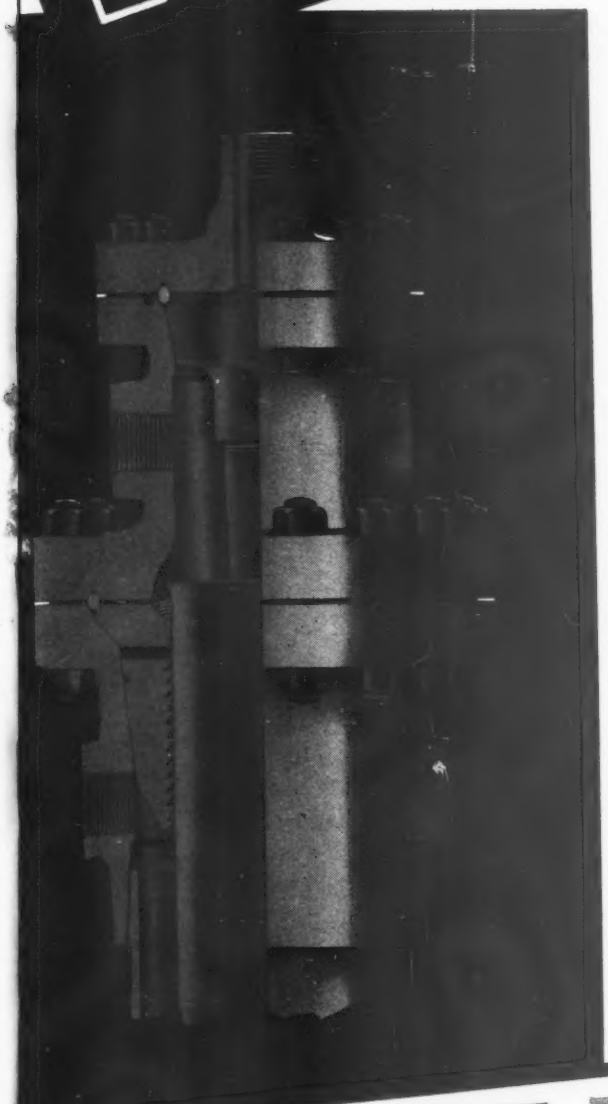

This 1000-lb. working pressure RECTORHEAD is engineered to give you the same efficient performance and safety for the operator as the popular high pressure RECTORHEADS. It makes possible the equipping of your lower pressure wells with API full bore 400 series flanges with positive assurance against leaks . . . WITHOUT THE USE OF RUBBER, COMPOSITION, OR OTHER PACKING THAT WILL DETERIORATE.

Figure 1 is the type 4RH casing head and the 4M tubing head. The 4RH casing head features slip suspension of the pipe with welded seal above and use of standard dimension API ring, thus eliminating all packing. As with all RECTOR welded hangers, the welding ring is allowed to "float" during the welding operation, thus insuring a stress-free weld.

The 4M tubing head is of the same general design as our high pressure tubing head, wherein a positive seal and hold down is affected solely by the API ring gasket. Where operators prefer to use mandrel suspension of pipe instead of slips we offer, as shown in figure 2, "A" Threaded Mandrel; "B" Single Welding Mandrel; "C" Double-Welding Mandrel. These three types of mandrel suspension are interchangeable in the same body. No packing is used in any of them.

Now, with low pressure as with high pressure, use RECTORHEAD . . . "Successor to the Braden Head".

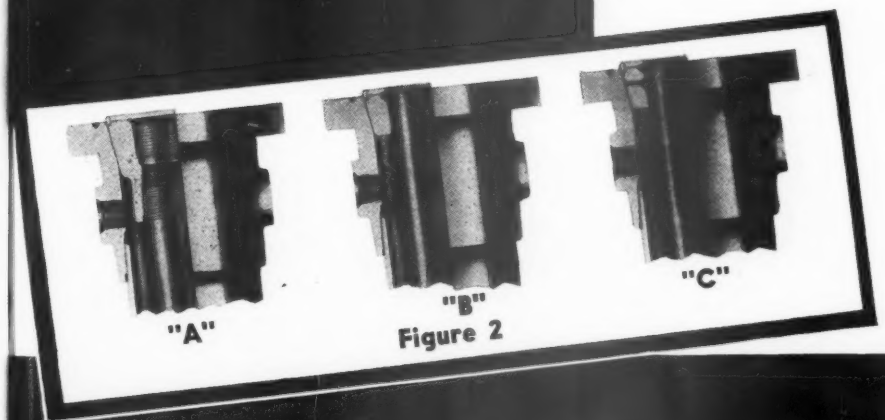

Figure 2

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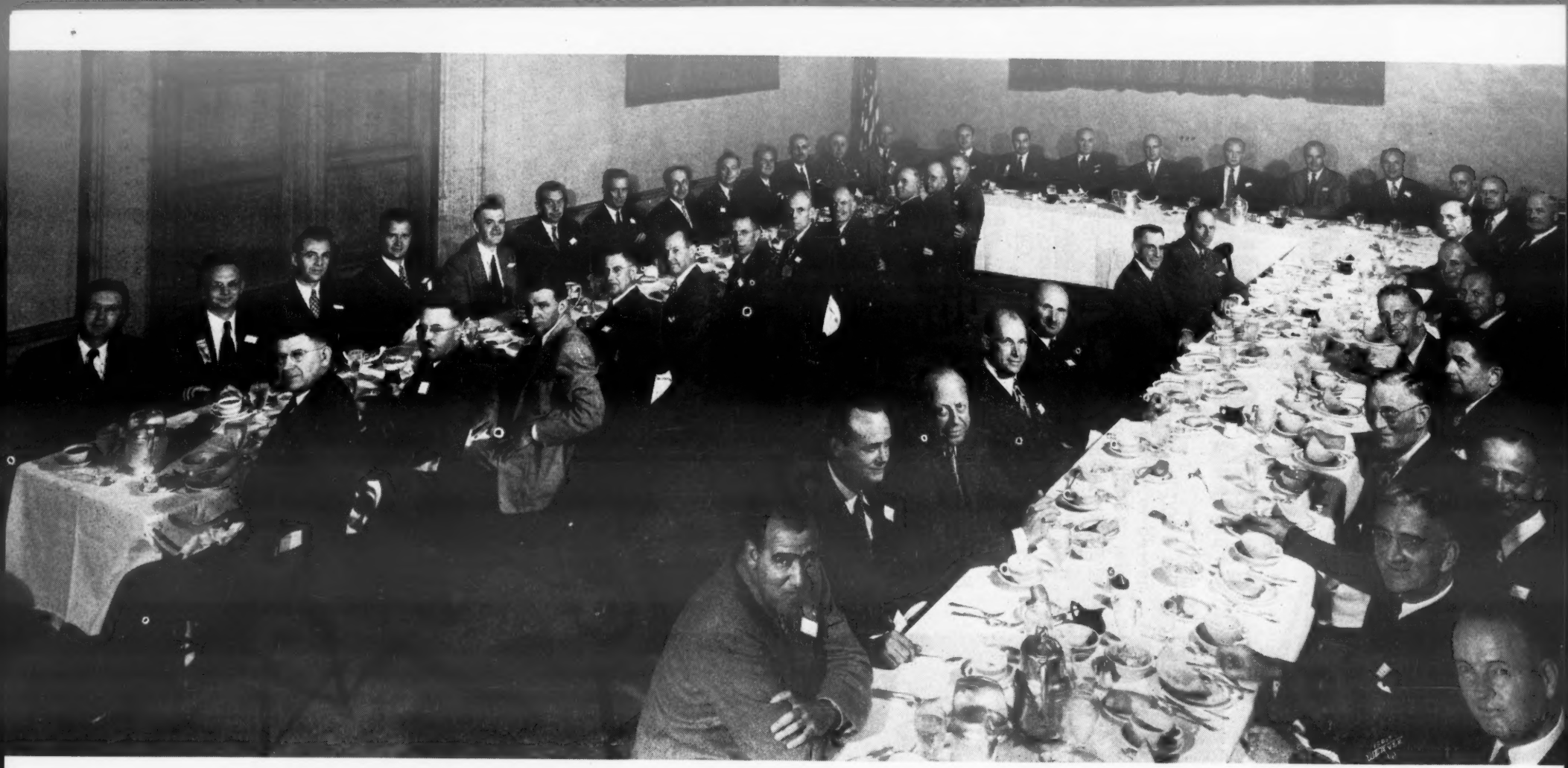

SPEAKERS LUNCHEON, BILTMORE HOTEL, FALL MEETING, CALIFORNIA NATURAL GASOLINE ASSOCIATION

Around outside of table, left to right: J. B. Taylor, E. P. Valby, Coles B. Bason, Earl A. Brook, D. M. Wolfe, F. J. Colton, R. D. Gibbs, I. B. Funk, William Moeller, Jr., W. C. Monroe, W. W. Robinson, Jr., John Rogers, W. L. Rifenberick, Fred Hartley, M. W. Kibre, H. A. Gehres, M. L. Arnold, M. M. Perkins, E. W. McAllister, F. D. Parker, William F. Lowe, C. L. Hutchings, A. R. Chandler, P. S. Magruder, George Howells, J. S. Fluor, A. H. Bell, R. C. Enderly, D. A. Cushman, A. K. Hegeman, T. L. Taggart, R. S. Tulin. Around inside of table, left to right: George Sowards, W. C. Dayhuff, H. P. Saueressig, R. W. Garman, M. L. Fort, H. E. Moulton, C. D. Gard, Harry Ransford, George L. Tyler, H. W Parmelee, H. L. Eggleston, W. A. Kirk, J. A. Campbell, G. C. McLaren, H. R. Linhoff, P. E. Fluor, R. W. Heath, L. V. Cassaday.

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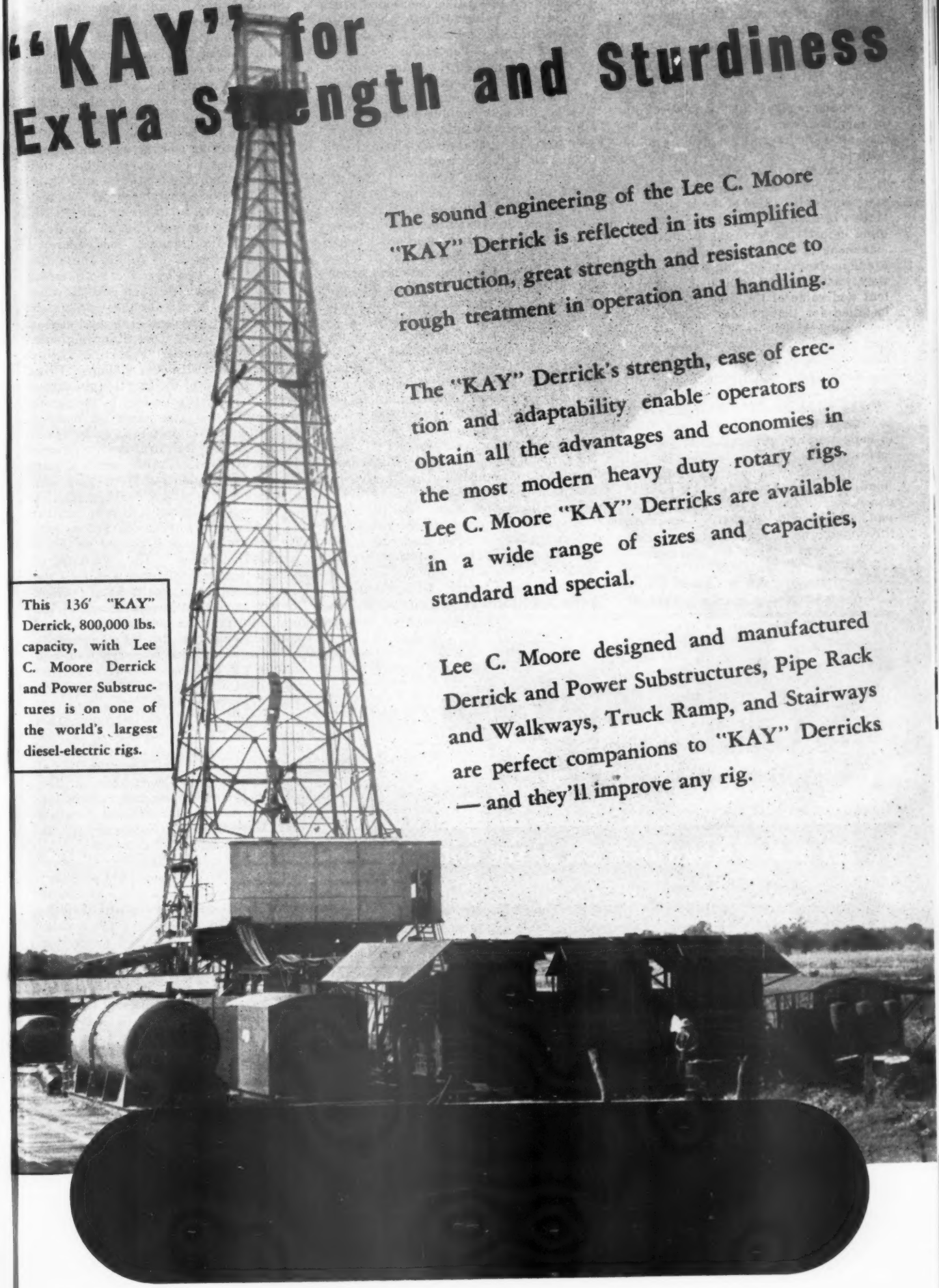
The "KAY" Derrick's strength, ease of erection and adaptability enable operators to obtain all the advantages and economies in the most modern heavy duty rotary rigs. Lee C. Moore "KAY" Derricks are available in a wide range of sizes and capacities, standard and special.

Lee C. Moore designed and manufactured Derrick and Power Substructures, Pipe Rack and Walkways, Truck Ramp, and Stairways are perfect companions to "KAY" Derricks — and they'll improve any rig.



This 136' "KAY" Derrick, 800,000 lbs. capacity, with Lee C. Moore Derrick and Power Substructures is on one of the world's largest diesel-electric rigs.

strumental in bringing about that greater spirit of cooperation, which is our objective.

"A second service which CNGA can render for the natural gas and gasoline industry is to work actively to enhance its prestige. This could be accomplished by conducting an educational program to familiarize other divisions of the petroleum industry and the general public with the value of the services performed by the natural gasoline industry. This should include the enumeration and a statement of the value of the facilities installed in each field by the natural gasoline industry to serve the producer; a statement of the economic loss which would be experienced if the gas produced were wasted; and a statement of the extent and value of the pipe line systems installed for the purpose of supplying the producer with residue dry gas for fuel. Such information should be released periodically to the oil editors of the newspapers and to the trade journals.

"The public should be informed of the role the natural gasoline industry plays in collecting and processing the natural gas used for domestic and industrial fuel. The public should also be made familiar with the products of the natural gasoline industry and their uses. An expanded publicity committee working through the newspapers and magazines should be the medium for accomplishing this.

"There are several new services which CNGA could render for its individual members. A few will be mentioned which would be of value to those who are engaged in technical work. The average engineer finds it impossible to keep up with advances in all the branches of science and engineering in which he must work. However, through cooperative endeavor, this task could be brought within the realm of possibilities. For example, we are kept up-to-date on physical constants through the work of the CNGA Physical Constants Committee. We are kept up-to-date on metering practices through the activities of the CNGA Gas Measurement Committee. Similarly, we could be kept up-to-date in other fields, such as the compression and pipe line flow of gases, the computation of vapor-liquid equilibria, and the computation of the number of plates required for strippers, fractionators, and absorbers.

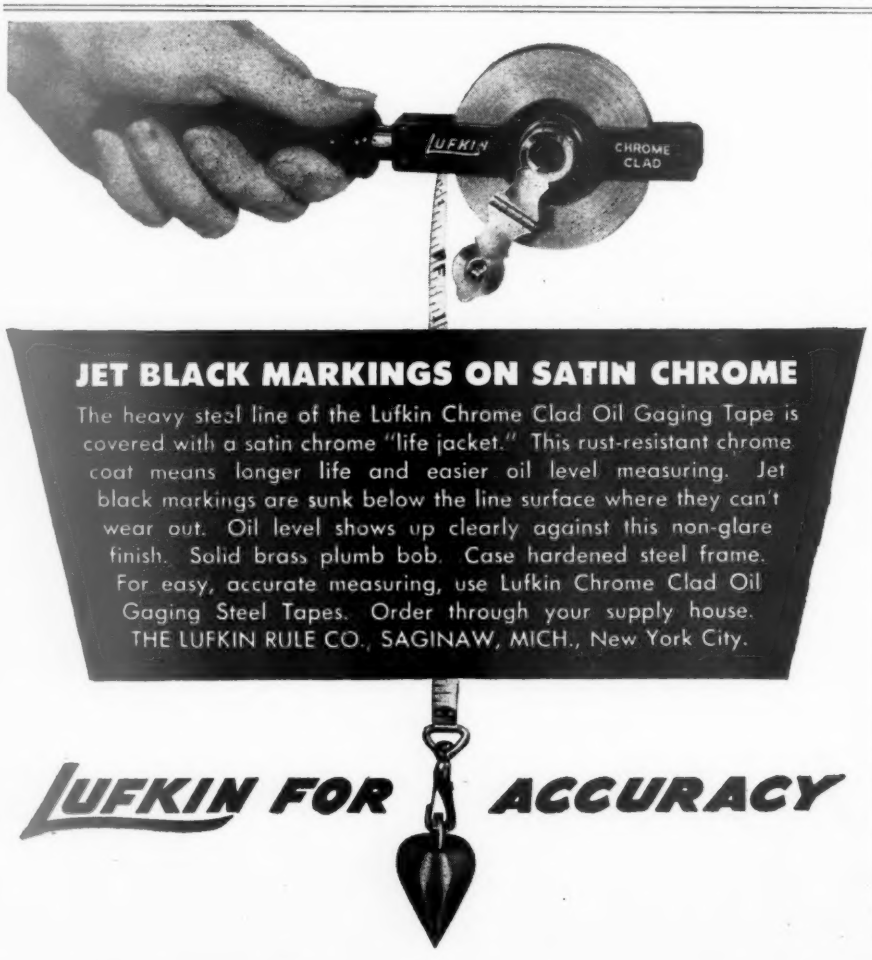
"Some years ago, a start was made along this line with the formation of a compressor committee. For the operating pressures then in effect, this committee made excellent recommendations for the computation of the capacity of compressor cylinders and the horsepower required for the compression of gas. Since that time, operating pressures have increased enormously and much research has been necessary to explain behavior at these higher pressures. Had the committee been continued in existence, their recommendations could have been revised from time to time in recognition of advances in the art as reported by such engineers as Laverty, Gill, Edmister, York, and Ridgeway, or as developed by the committee. Similarly, in the other fields mentioned, engineers could be provided with recommended methods of procedure revised as frequently as additional research required. This work should be carried on by technical subcommittees. An endeavor should be made to include in such committees technical men from the refining division and from the engineering contracting companies."

Following the address by the president, the chairman next presented M. M. Perkins, process engineer, M. W. Kellogg Company, in an address on, "Utilization of Propane and Butane for Motor Gasoline Manufacture." This covered various processes by which these two hydrocarbons can be converted to motor fuel and indicated their worth when used as feed stocks for these processes.

The third speaker of the afternoon was F. D. Parker, consulting engineer, whose address was, "Peacetime Utility of Wartime Petroleum Refining Processes." In view of the fact that the petroleum industry is even now in the throes of reconversion, this paper commanded great interest. It presented an informal review of the technical and economic factors involved in the conversion of aviation gasoline plants to peacetime use.

The final paper was by Fred Hartley of Union Oil Company. It was entitled "Commercial Synthesis of Toluene by Hydroforming and Recovery by Azeotropic Distillation." The synthesis of toluene was a vital process during the war and is certain also to be of decided import in the future operations of the oil industry. The author summarized methods employed by his company to manufacture toluene from crude oil and natural gas and discussed at length the separation of the toluene from paraffinic and naphthenic hydrocarbons of approximately the same boiling range. This paper was a fitting windup of a fine technical program on which Chairman W. L. Rifenberick and his committee of arrangers are to be congratulated. The personnel of this committee were as follows: E. A. Brock, Southwest Welding and Manufacturing Company; C. E. Gotterba, Richfield Oil Corporation; M. W. Kibre, General Petroleum Corporation; Fred Hartley, Union Oil Company; C. L. Hutchings, Tide Water Associated; and R. S. Ridgway, Standard Oil Co.

For the banquet and the fine vaudeville show offered by Harold Trask, due credit goes to E. A. Brock and his entertainment committee, who dished up a nice meal and a good show in spite of some formidable difficulties. This committee mustered such stalwarts as J. E. Gesner, Reliance Regulator Company; P. W. Mettling, The Cooper-Bessemer Corporation; Carlos Munoz, The Fluor Corporation, Ltd.; Ted Rees, Southwestern Engineering Company, and Harold Baxter, Parkhill-Wade, so the success of the affair was assured. And while we are handing out bouquets, we must not overlook George Tyler, who had a hand in practically everything that went on, thus helping in no small measure to keep the entire program clicking along efficiently and smoothly. ★ ★ ★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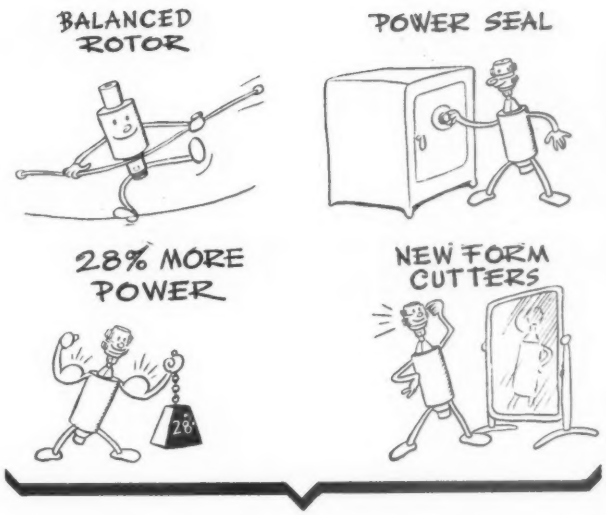

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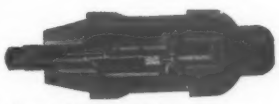
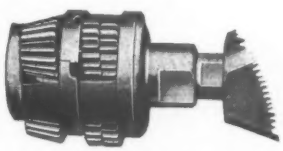
Cut Tube Cleaning Costs

LESS DOWN TIME! NO TUBE DAMAGE!



Balanced Rotor, Power Seal, 28% more power, New Form Cutters—these are the Airetool Tube Cleaner features that reduce tube cleaning cost . . . eliminate tube damage . . . reduce down time.

The Balanced Rotor in Airetool's powerful motor eliminates fricton so that all power is directed against the load. The *Power Seal* feature stops power waste in the operation of the motor and produces constant torque at low speeds, eliminates dead centers and allows the motor to be loaded to 50r.p.m. without stalling. Motor picks up immediately when load is released. As the result of the features of Airetool Motors, 28% greater power is developed.



The Airetool New Form Cutters eliminate the tendency of cutters to track and damage tubes. This is made possible by an exclusive Airetool development—the periphery of the cutter milled to divide sections of the circumference into teeth of various pitch, as shown in the illustration, which prevents cutter finding the same spot in a tube wall during each revolution.

Airetool Tube Cleaners are offered in a variety of sizes and styles to efficiently and economically meet every tube cleaning problem. Made for tubes ½ in. to 24 in. I.D.; straight or curved.

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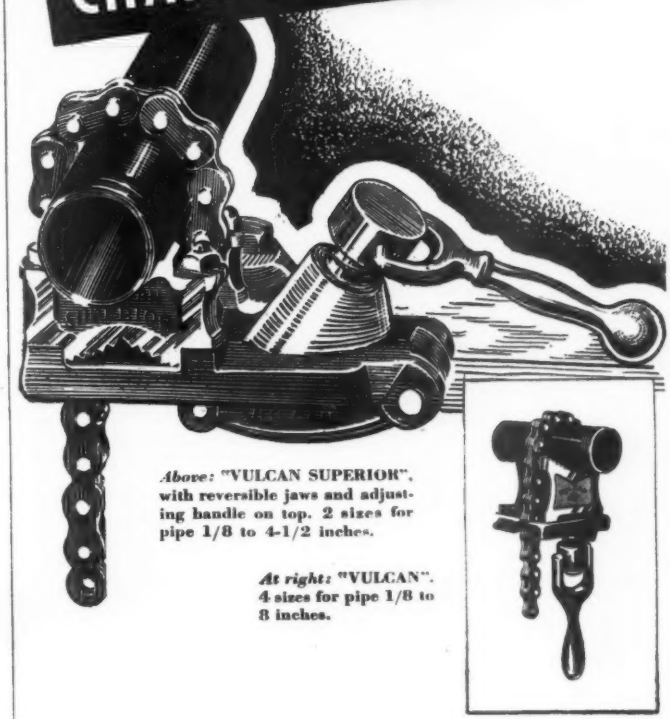
"VULCAN SUPERIOR" CHAIN PIPE VISES



Above: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

At right: "VULCAN". 4 sizes for pipe 1/8 to 8 inches.

● Williams "Vulcan Superior" is an improved vise featuring "over-head" adjustment handle . . . making it easier and faster to use. Jaws are reversible providing double the service of conventional vises. It has larger capacity too. Each vise takes pipe 1/2" larger than other chain pipe vises of similar size. Like all Williams tools it is fully guaranteed. Sold by Industrial, Plumbing & Oil Field Distributors everywhere.

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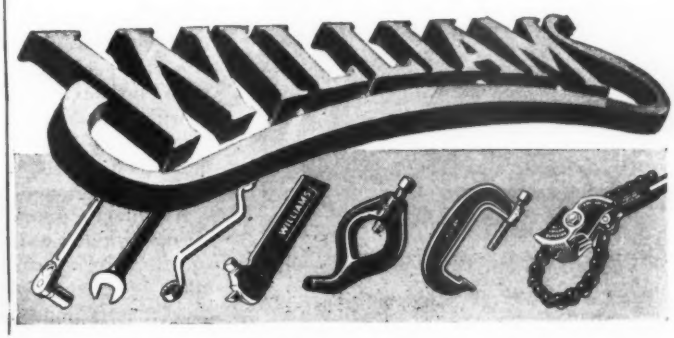

Shell to Build New Laboratory

GROUND will be broken in Houston, Texas, in the near future for the construction of a new oil exploration and production research center devoted to studying new methods of finding oil and of getting it out of the ground, officials of the Shell Oil Company announced recently.

The new research center, which will cost nearly a million dollars, is expected to be completed by spring, and will house the company's recently organized Division of Exploration and Production Research. The new division, an independent entity within the Shell organization, has its headquarters in Houston.

The new laboratory's research program, company officials said, will principally concern itself with augmenting America's petroleum resources by developing new and more efficient methods for discovering oil and for recovering it in maximum quantities from the underground reservoirs in which it is found. Oil industry exploration and production men are generally agreed that the discovery of new petroleum reservoirs is becoming increasingly difficult, and that large quantities of the oil in present reservoirs are not being brought to the surface by today's production methods.

Another oil company plans large research facilities to develop new exploration and production knowledge.

H. Gershinowitz
Director

M. K. Hubbert
Associate Director

The new center will consolidate under one roof research in physics, chemistry, and geology as they are related to petroleum exploration and production. It will also serve as an instruction center for training exploration and production field men in the new techniques and methods developed at the laboratory.

Architect's plans call for a two-story, air-conditioned building covering 40,000 sq. ft. Interior dividing walls will be made of glazed hollow tile, adapted to easy installation and removal, so that the size of various laboratory rooms can be changed at will. Provisions have been made for a first aid room, locker and shower rooms, a library, two conference rooms, an outdor dining terrace, and a cafeteria for 75 persons. Contract for the building construction has been let to the Austin Company, Houston.

The building is designed to accommodate a working staff of 130 persons, which eventually will be expanded to 155. In an existing air-conditioned building adjacent to the laboratory, an additional 75 persons will work on the design and manufacture of special exploration and production instruments.

The director of the new Division of Exploration and Production Research is Dr. Harold Gershinowitz, who since 1942 had been research director of the company's manufacturing department in New York. Dr. Gershinowitz joined the Shell Oil Company in 1938 as research technologist, after having served a number of years as research associate at Harvard and Columbia universities, and was in charge of the research laboratory of the Houston refinery from 1940 to 1942.

Assisting him as associate director will be Dr. M. King Hubbert, who, before joining Shell in 1943, had been a lecturer in geology and geophysics at Columbia University, and a consultant to the Office of Economic Warfare.

★ ★ ★

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A REGULAR FEATURE
appearing in
THE PETROLEUM ENGINEER
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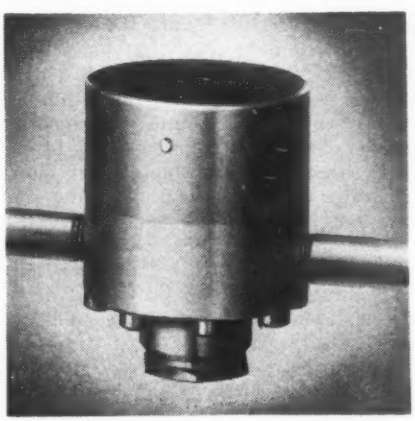
(1) *Grove regulator*

The new small and compact Grove Mity-Mite regulator weighing less than 2 lb. and measuring roughly 2¾ in. by 3¼ in. is suitable for handling initial pressures up to 3500 lb. with adjustable control range from 5 to 1500 lb. Special models can be supplied for higher initial pressures ranging up to a maximum of 5000 lb. Capacity range is equal to that of regulators ten times its size. Although primarily designed for air and gases, including hydrogen, nitrogen, oxygen, etc., this diminutive yet powerful unit can also be supplied for liquid service. Its rugged strength is attributable to stainless steel ports and the homogenous



structure of Duraluminum from which it is made. Unique valve and seat construction was especially engineered for positive dead-end shut-off. Like all Grove regulators it is instantaneous in its operation, the manufacturer says.

Available for ⅛ and ¼-in. pipe size this tiny unit was originally developed and thoroughly proved in wartime service, where it was extensively employed in controling the actuating medium on rockets and pack type flame throwers.

Grove Regulator Company, 6569, 65th Street, Oakland 8, California, is the manufacturer.

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(2) *Titrometer*

Precision Scientific Company, 1750 North Springfield Avenue, Chicago, Illinois, is now offering a new titrometer that determines the free and combined acidity of material in either aqueous or non-aqueous highly colored or opaque solutions. The instrument was originated by the Shell Development Laboratories primarily for determining the acidity of highly complex mixtures of lubricating oils, either completely opaque or so dark in color that the routine acidimetric color titrations could not be made. The titrometer has been found applicable to determine the acidity of used lubricants, detergents, fats, turbine oils, oil additives, motor oil sludges, asphaltenes, crude oils, asphalt, asphalt residues, distillates, distillate bottoms, polymers, rubber, vegetable and animal oils, fats, waxes, greases, common solvents, and other water solutions. The potentiometer method is reliable and reproducible, and the titration media is capable of dispersing or dissolving sufficient quantities of the water insoluble material under test, according to the manufacturer.

The operation is similar to that of the pH determination. The instrument has two complete titration stands. The alternating current operated electrometer allows the use of any electrode system in aqueous or non-aqueous solutions. The calomel-glass electrode is readable to within 0.02 pH units. The titrometer is equipped with meter scales and potentiometer circuits that give a range of minus 1.65 to plus 1.65 volts readable to 0.5 millivolts.

The use of sturdy glass electrodes and high resistance titration media in conjunction with a versatile potentiometer capable of measuring the potential between the electrode terminals of the cell having a resistance up to 5000 megohms insures the long life and accuracy of the instrument.

The step potentiometer is used in con-

junction with the vacuum tube electrometer making the instrument continuously indicating, which requires less manipulation by the operator and enables easy and definite indication when the potential reaches equilibrium. The step potentiometer gives wide range and high sensitivity in a single indicating meter and can be used for routine or special determination.

No prior knowledge of the magnitude or sign of the potential is necessary as the electrical characteristics of the circuit and meter allow measurement of the system's potential without the danger of polarizing the electrode system. Two titrations can proceed simultaneously owing to the dual feature of the system, and the two diverse electrode systems may be left permanently set up.

The titrometer is portable, has a power consumption of 10 watts and is suitable for continuous duty. The entire electronic system is shielded and enclosed in a metal housing. No batteries or transformers are required. It has a plus or minus charge of 10 volts in a 115-volt a-c. line, which will result in a d-c. voltage change of only ±0.1 per cent.

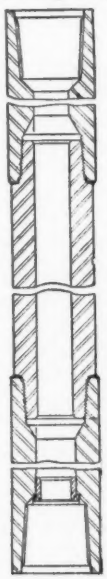
When determining the acidity in complex mixtures the Precision "Shell" dual titrometer is also an aid in identifying the acid constituents of the mixture, and in addition, it provides a record of possible changes taking place during sample analyses.

The titrometer has been found suitable for conducting ASTM Proposed Method of Test for Saponification Number of Petroleum Products by Electronic Titration and also for ASTM Tentative Method D-644, "Neutralization Number of Petroleum Products by Electrometric Titration."

(3) *Drill collar*

Sperry-Sun Well Surveying Company has recently added to its line of well surveying instruments and services a new service, the S-S non-magnetic drill collar rental.

The use of this drill collar permits the taking of directional single shot records inside the drill pipe. There is no need to remove the drill pipe from the hole or to raise the drill string to allow the instrument to dangle through a specially designed, but inefficient, bit, the manufacturer says.



The S-S non-magnetic drill collar is placed immediately above the regular bit and the non-magnetic section carries the directional single shot instrument and protects it against loss and damage. The records obtained are accurate because the instrument, being seated inside the drill collar, is always parallel to its walls, the makers assert.

The non-magnetic sections of the S-S drill collar are made of "K" monel metal.

A cross-section of the S-S drill collar is shown in the accompanying illustration. It will be noted that the tool joints are made of steel and are welded to the "K" monel metal section by a special welding process.

Extensive field tests that have been made with the non-magnetic drill collar have conclusively demonstrated that by its use directional single shot records can be obtained at a great saving of rig time, that the records obtained are more accurate, and the operation of the single shot instrument is less hazardous, the manufacturer states. The use of the S-S non-magnetic drill collar is particularly advantageous in directional drilling in which the reaching of the sub-surface objective with the least deviation and with the greatest saving of rig time counts.

The S-S non-magnetic drill collars are made in standard sizes. At the present time there are available for rental at the company's Houston, Texas, and Long Beach, California, offices, drill collars of 6 in. O.D. and 6¾ in. O.D. Additional sizes will be made available in the near future.

World's Deepest Producer

Deepest producing oil well in the world now is Shell's State-Smith No. 1, a wildcat at Weeks Island, Louisiana swamplands. Drilled to 14,023 ft., it is producing gas-condensate from 13,505-20 ft., the greatest depth ever known to produce.

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3 All HILL-HUBBELL processed pipe is factory inspected and approved before shipment.

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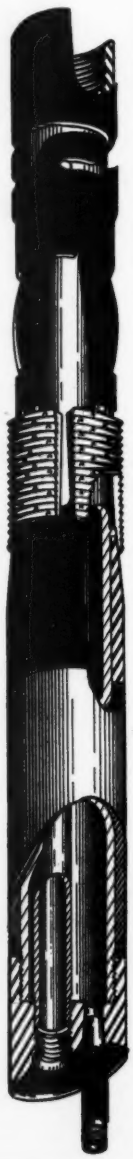

Tubing Size

This high quality Robinson Packer is run on tubing, and used in flowing and pumping wells . . . and can be used to pack off water in leaky casings. Other high standard features—

- Case hardened steel slips.
- Rods may be installed after well ceases to flow, and packer may be used as pumping packer.
- May be raised or lowered and reset.

ROBINSON PACKER CO.

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TULSA, OKLAHOMA

Factory: Coffeyville, Kansas

(4) *It's in the bag*

Industrial plants expecting to reconvert to peacetime production may find the procedure unexpectedly speedy and inexpensive in the light of a new technique that has been developed in the low-pressure laminating of parts. This new method, which involves the use of vacuum bags made of compar, drastically cuts the time and cost of designing and producing strong, lightweight plastic parts, according to the manufacturer. It eliminates the expense of costly dies and materially cuts time required to design new parts, it is asserted.

The extensive experimentation which brought about this new technique was conducted by Owens-Corning Fiberglas Corporation. Prototypes of low-pressure laminated plastic parts have been built in their research laboratories. Sheets of transparent compar, the vinyl resin derivative developed by Resistoflex Corporation, are used to form the vacuum bags in which parts are cured. The use of this material has minimized the special tailoring of bags, for complexity of contour is a minor problem when the vacuum bag is made from sheets of flexible compar.

The same qualities that characterize solvent-proof compar tubing, protective clothing and molded products make sheet compar outstanding in the laminating process. Its toughness permits wrinkling of the bag without prohibitive wrinkling of the laminate. This wear-resistance further precludes the danger of breaking the film in forming the vacuum bag.

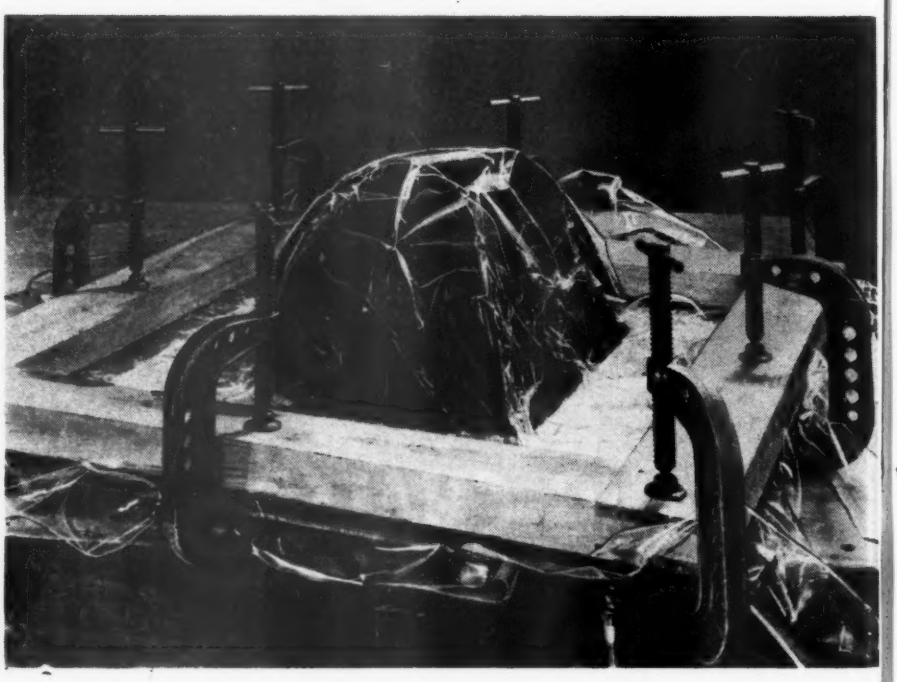
Flexible and elastic, compar readily forms to even the most intricate of parts. The factor of transparency is of equal importance in that it provides visibility at all times, revealing any air bubbles that might form before the laminate is placed in the curing oven. In addition, the water-receptivity of this particular compound of compar has a distinct advantage in forming vacuum bags. The vacuum seal is quickly accomplished merely by dampening edges to be joined and pressing them together by hand.

Let us take as an example the production of a Fiberglas-plastic air duct. The first step in making the air duct is the preparation of the form block. A plaster-of-paris cast is made of a wood pattern of the part. From this cast a slush-molded core is then lifted. This is used as the form over which the resin-impregnated Fiberglas fabric is laminated. The hollow plaster core is insulated from the resin by a coat of lacquer followed by a coat of polyvinyl alcohol solution.

Next the required number of pieces of Fiberglas cloth are trimmed to fit the form block. In cases of extreme compound contour, flutes are cut in the cloth to prevent wrinkling. Wrapped successively on the block, each layer of the cloth is brushed with liquid resin until the desired thickness is obtained. The best mechanical bond is produced when rather heavy, loosely woven cloth is used. Fewer plies of such material are required to obtain the desired thickness, with compound curves more readily accommodated and the flow of resin through the cloth facilitated to obtain dimensional stability. To obtain maximum strength, the vegetable oil must be removed from the cloth before lamination.

When the laminate has been formed, it is set into an open-end bag made of the compar. After wrinkling the compar to conform closely to the shape of the air duct, the bag or casing is sealed

Resistoflex compar sheet used as a vacuum diaphragm or blanket over a laminate reinforced with Fiberglas cloth. In this operation the vacuum blanket is clamped securely against a rigid, non-porous plate that supports the mold. The vacuum fitting may be seen in the lower right foreground. In some cases this fitting is attached through the compar diaphragm.



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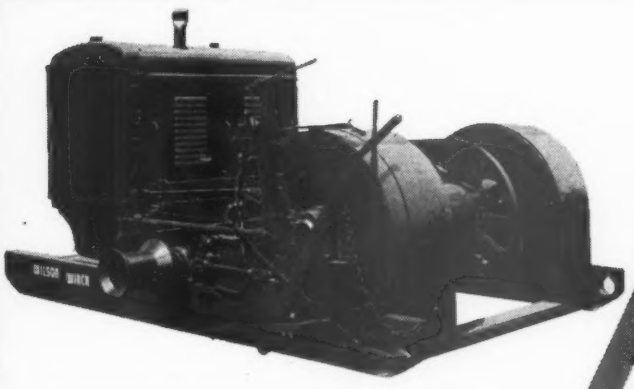

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producing sufficient tackiness of the vinyl resin to insure a vacuum seal when the edges are pressed together. A hole is then cut in the bag for the installation of the vacuum fitting. A truck tire valve stem makes a convenient fitting, with a few extra plies of compar used as a gasket under the top washer to prevent leakage.

In applying the vacuum pump, all air is exhausted from the compar covering. Atmospheric pressure fits the compar bag to the laminate, squeezing out remaining air pockets and excess resin.

The laminate is now ready to be cured. Rolled into the curing oven, polymerization of the resin is completed. Pressure from 0 to 15 lb. per sq. is needed only to keep the laminations in close contact with each other. The heat required to cure depends upon the resin used, in most cases ranging from 180°F. to 250°F.

After the laminate is completely cured, it is allowed to cool before being separated from the form block. The part is then completed—flanges trimmed, holes drilled or clamps installed according to specifications.

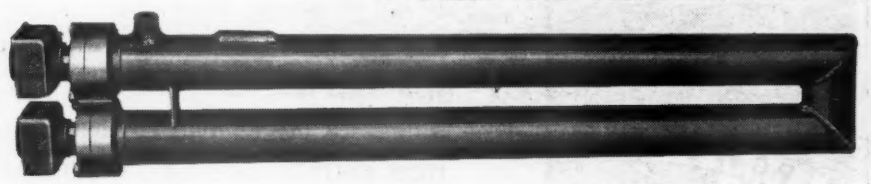
Although the use of a compar vacuum bag in combination with a curing oven is rapidly becoming standard practice, other methods are sometimes employed. One method is to place the laminate on a table. A large sheet of the transparent compar is placed over it and the edges clamped with a wooden frame. A vacuum is then drawn and the entire assembly is ready for curing in an autoclave.

The successful application of compar to low-pressure laminating provides important savings that open a large field of plastic tooling. One major advantage is that the production time for laminating is drastically cut, with corresponding savings in the cost of changing designs. This factor is an advantage in fabricating small quantities of parts that would have entailed considerable time and cost if produced of metal, the manufacturer points out.

(5) *Heat exchanger*

The Brown Fintube Company, Elyria, Ohio, manufacturers of Brownweld one-piece fintubes and fintube heat transfer products, has introduced a new heat exchanger that employs electrical resistors as the heat source.

According to a company spokesman, the electrical resistors are encased inside a length of standard Brownweld fintube. Current density of typical resistors now in use is 4 kw. per linear foot of fintube.



Notwithstanding this high rating on the interior of the fintube, the rating on the outside surface (due to the large ratio of exterior to interior area of the fintube) is only about 8 watts per sq. in., thus avoiding high skin temperatures that might cause carbonization of heat sensitive materials, such as sugar syrups and molasses, or coking of hydrocarbons, petroleum products or organic oils.

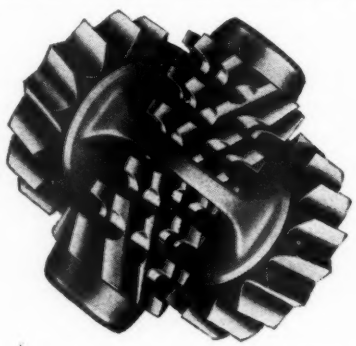
Brownweld fintubes fitted with electrical resistors are thoroughly practical for use in double tube, bayonet, vertical immersion or other types of heat exchangers, it is asserted. They permit great flexibility as to the size and capacity of the equipment. Each installation is engineered to the individual, specific duty.

Brown fintube electrical resistor heat exchangers are ideally employed when steam is not available, when it is desired to eliminate the auxiliary piping required when steam is used, or to heat the fluid to higher temperatures than can be reached with steam, the manufacturer states.

The electricaliy operated units insure 100 per cent absorption of heat into the fluid being treated, the temperatures can be more easily controlled than in heat exchangers using steam, and they are ideally used, not only in a wide variety of commercial applications, but in many laboratory and pilot plant services as well, it is said.

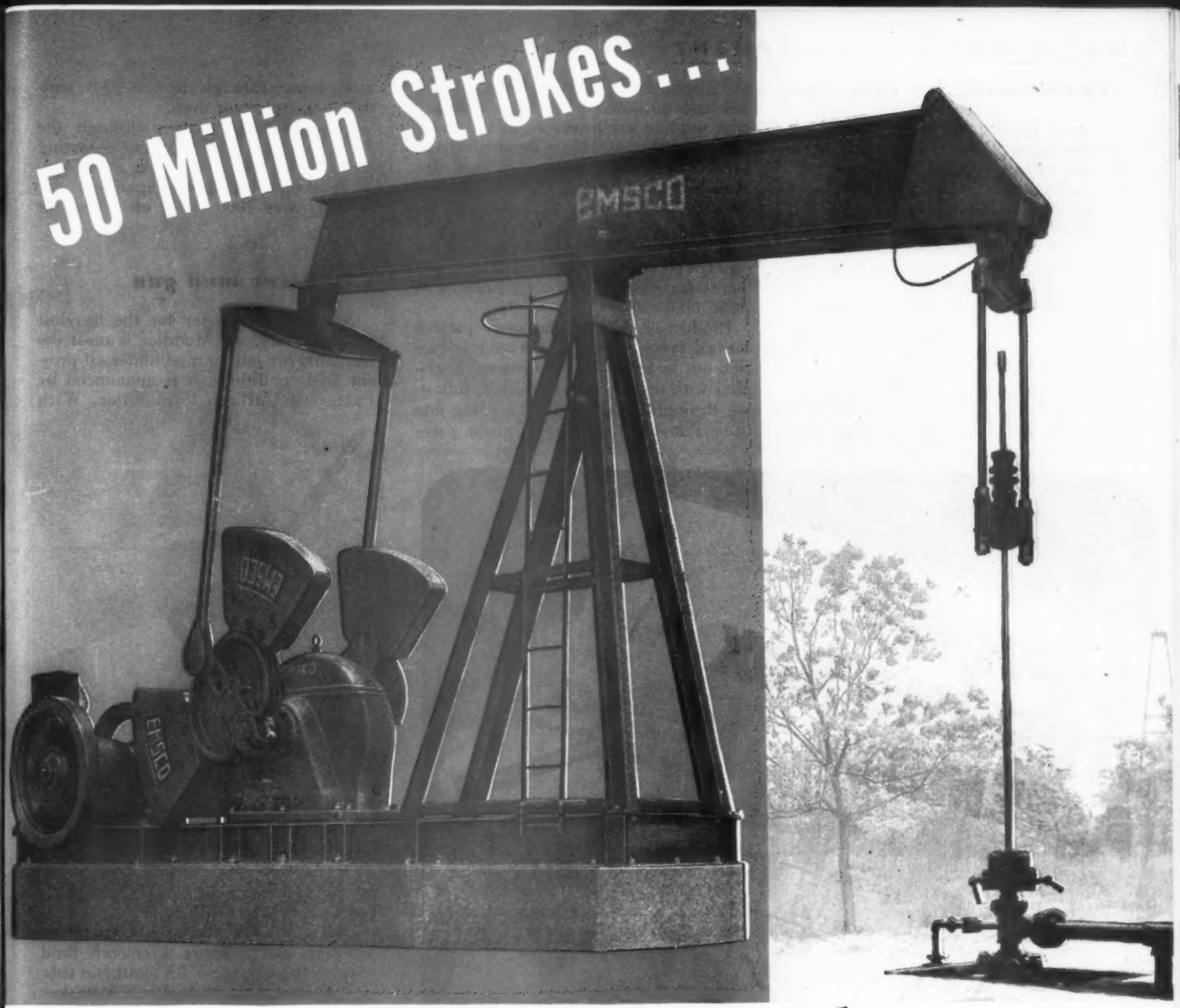
(6) *Rock Bit*

The H. C. Smith Oil Tool Company has announced a new long-tooth rock bit for drilling through sticky and sandy shale. This new addition to the H. C. Smith line of rock bits is known as the

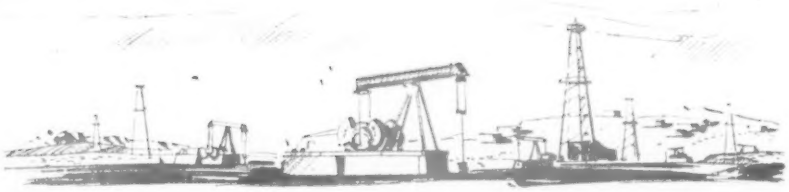


K-2 and embodies an improved bearing design that promotes longer bearing life, according to the manufacturer. The cross-section cutters have long, widely-spaced teeth, hard-faced with tungsten carbide before hardening. The tooth design provides good chipping and slicing action. Field-tested for nearly two years, the K-2 maintains the straight hole reputation of Smith rock bits, it is said.

50 Million Strokes...



...is only a part of a lifetime



SADDLING A WELL HEAD IS OUR JOB

50 million working strokes covers only a portion of the life-span of thousands of Emsco Unit Pumpers now in operation. Long life is the specification to which every feature is designed.

EMSCO UNIT PUMPERS are manufactured for light, medium and heavy pumping loads and with a range of pumping speeds and strokes to meet any pumping conditions. Emsco Unit Pumpers give dependable operation after years of service.

EMSCO DERRICK & EQUIPMENT COMPANY

HOUSTON, TEXAS LOS ANGELES, CALIF. DALLAS, TEXAS

EMSCO

REG U.S. PAT. OFF.

(7) *Electrode for cast iron*

A new welding electrode for making machinable welds in cast iron has been introduced as a product of The International Nickel Company's new electrode plant at the company's Bayonne works. It represents a development by the Inco Development and Research Division's Research Laboratory with the cooperation of the Bayonne works.

Besides this new electrode, designated by the trade name Ni-Rod, another new electrode also has been developed. This is the "133" 80-20 nickel chromium electrode for welding the Inconel side of Inconel clad steel. Besides these, 6 other electrodes are now being produced at the plant for arc welding. Gas welding rod and uncoated wire for submerged melt welding are produced at the Huntington works of the company. The 6 types of electrodes are designed for Monel, Inconel, nickel, "L" Nickel, "K" Monel, 70-30 cupro-nickel, and the various clad steels. Among them is another new product, "132" AC-DC rod for Inconel. The Bayonne works also produces fluxes for gas welding and brazing of these materials.

Production follows the same pattern for all types of electrodes and is carried out in automatic equipment, beginning with the mixing of the flux, following through the slug press, loading into the magazine of the flux extrusion press and passage through the new 90-ft. multiple-pass conveyor oven.

Each electrode passes through the oven, back and forth, five times, starting from the top and discharging at the lowest level end. Maximum capacity of the plant is over 1000 lb. of electrodes an hour.

(8) *Mixer mud gun*

A real speed mixer for the heaviest constant duty, the Muddler is most dependable for jetting mud under all present field conditions, it is announced by Patterson-Ballagh Corporation. With

two surge chambers, the Muddler mud gun completely breaks up weight and mud conditioning materials, such as Aquagel, and delivers a smooth fluid mixture through the PBX synthetic rubber-lined nozzle. A no-leak handle makes adjustment easy but the gun stays locked in any position from horizontal to vertical and does not spin under the highest operating pressures, it is stated. Free movement and long life of glands and packing result from chrome faced packing glands and Alemite-fitted swivels.

Thorough factory pressure testing plus the all-steel construction insure readiness for quick installation and a reliability that makes "The Speed Mixer" the best name for the Patterson-Ballagh mud gun with the code name, "Muddler," the company announces.

(9) *Drilling scale*

To meet the need in many shipyards for a line scale between the regular 100,000-lb. "Packer Special" and the 180,000-lb. "Conrad" model, Line Scale developed a new model with 145-000-lb. capacity. In shipyards this scale has already been used; it is known as the "Shipbuilder." This scale proved so popular, Line Scale decided to add it to its regular line of drilling scales. In the oil field this scale is known as the "Drillmaster." It is especially adapted to the larger sizes of slim hole rigs.

Complete
STUFFING BOX
ASSEMBLY
all in
ONE
UNIT
PACKING GLAND
HANDLE
GLAND FOLLOWER
PACKING RINGS
SPACER
JUNK RING
BALL
BODY
This "American" pumping well Christmas tree saves from 12 to 14 inches over a regular stuffing box hookup, which is particularly advantageous in long stroke pumping units.
The entire pumping head assembly is included in this one unit . . . a stuffing box, pumping tee with bleeder outlet, and a check valve.
AMERICAN
IRON AND MACHINE WORKS CO.
OKLAHOMA CITY, OKLAHOMA
PRODUCTS FOR PERFECT . . . PERFORMANCE
Office & Warehouse, Houston, Texas. Export office: 420 Lexington Ave., New York City, N.Y. — California Representative: Hooper Mch. Works, Inc., Bakersfield, California.

DEPENDABILITY PROVED in a greater variety of applications than *any other diesel*

Proved

In heavy-duty trucks, both on-the-highway and off-the-highway.

Proved

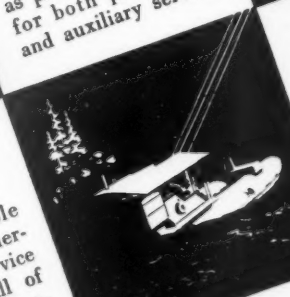
In all types of heavy-duty earth moving, road building and material handling equipment for contractors and aggregates producers.

Proved

In tugs, ferry boats, commercial fishing boats, fire boats, as well as pleasure craft . . . for both propulsion and auxiliary service.

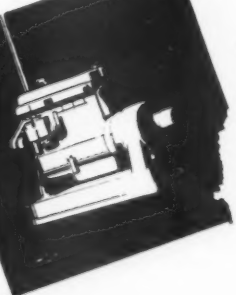
Proved

In every kind of mining power application . . . both above ground and below . . . stripping, loading, hauling, stationary and marine.



Proved

In yarders, loaders, trucks, tugs and sawmills . . . in all classes of portable and stationary service . . . on the show and in the mill.



Proved

In rotary rig, cable tool, pumping, generating and well service applications in all of the important petroleum producing areas.

Proved

In locomotives, motor trains, maintenance-of-way and other types of equipment operated by the nation's railroads.

Read the Record

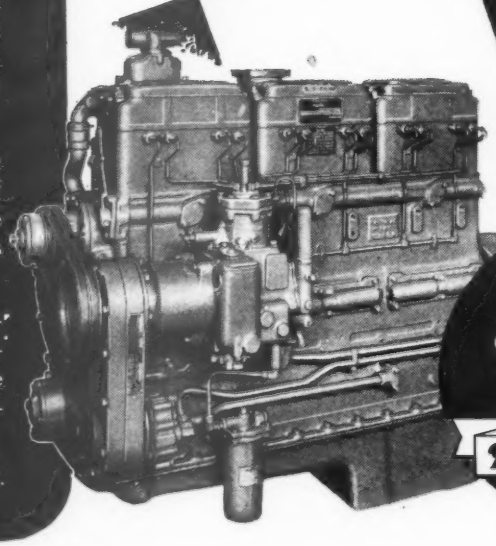
1. In the world's largest petroleum producing region—the Mid-Continent Area—Cummins Diesels power more rigs than any other diesel engine.

2. More yarders, loaders and trucks in the Northwest Woods are powered by Cummins Diesels than by any other single make of diesel engine.

3. On the Mesabi Iron Range—largest in the world—most of the rubber-tired earth and ore moving equipment is Cummins Diesel-powered.

4. More than 90% of the long-line, franchise-operated, heavy-duty, diesel-driven trucks in the 11 Western States are Cummins Diesel-powered.

CUMMINS ENGINE COMPANY, INC.
Columbus, Indiana



CUMMINS DIESELS

SINCE 1918...PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

(10) *Speed increaser*

Stepping up the speed from 400 r.p.m. to 3553 r.p.m. and delivering 300 hp. to each of two pumps from a single 600-hp. engine is the job that the Farrel two-pinion speed increaser is designed to do. Speed increasing through gears is a more difficult, more exacting service than speed reducing. Add to this peculiarity the torque characteristics of the diesel engine, and it will be seen that the problems involved in gear units of this kind are quite different from those in ordinary industrial transmissions. Questions of vibration, of impact stresses, of noise, of lubrication of gears and bearings, can be answered only by specialized skill and experience in design and manufacture, combined with a high degree of precision in machining and assembly.

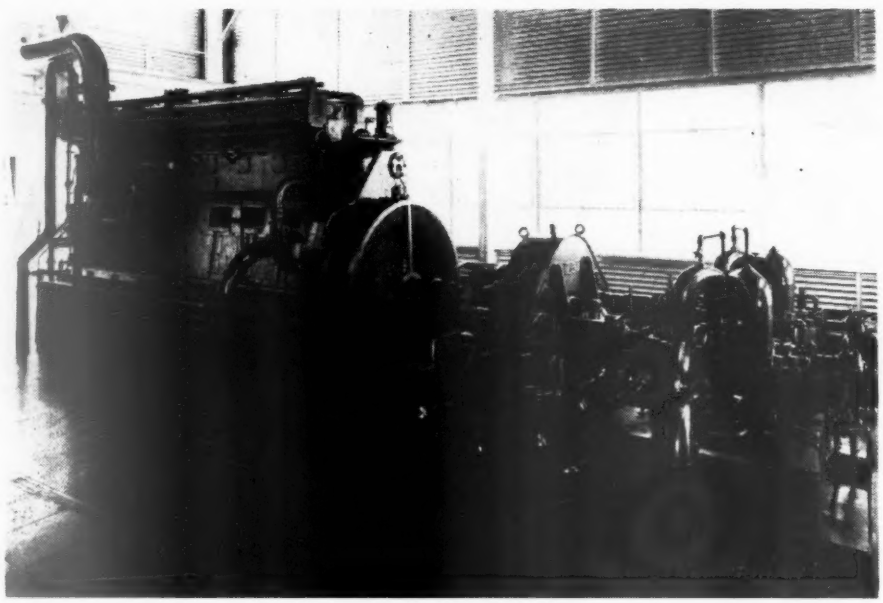
The gears and pinions in Farrel speed increasers are of materials selected for strength and toughness to resist wear. They are precision generated by the famous Farrel-Sykes process and are of the continuous tooth herringbone design that utilizes the full face width without a center groove.

Oversized shafts, ground to close tolerances and mounted in precision finished bearings, provide the necessary rigidity to guard against torsional deflections under peak torque variations. A self-contained, circulating oil system provides spray lubrication to all bearings. A heavy, rigid housing of welded steel construction assures permanent alignment of all moving parts.

Besides these two-pinion units, Farrel speed increasing units with single output shaft are available in a standard series of 47 sizes, with ratios ranging from 1¼:1 to 12:1. If higher ratios are required, units using two sets of gears can be supplied with ratios from 12:1 to 40:1.

Curtailment of Farrel-Birmingham's "5-star" production of gears and gear units from the U. S. Navy has released facilities for increased production of gear units for oil field service.

A Farrel two-pinion speed increasing unit installed in a pipe line pumping station in California.



(11) *Sealing compound*

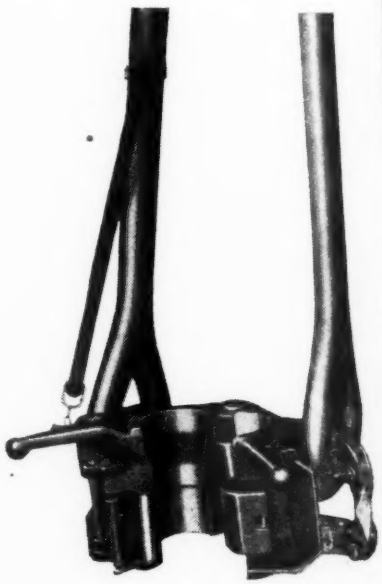
Bowser, Inc., Fort Wayne, Indiana, has introduced a new pipe sealing compound and gasket cement known as Black Magic. The product can be used in services involving gasoline oils, water, steam, and many other liquids except those containing alcohol or those liquids made with an alcoholic base.

According to the manufacturer, Black Magic forms a permanent seal in pipe joints and gaskets yet retains enough flexibility to permit expansion and contraction of metals without cracking. It does not become brittle with age, which is important when used on underground piping. The compound is always ready for use, the makers state; there is no mixing and no waste. The convenient tube keeps the compound fresh and ready to use in its original consistency. Black Magic clings to metal with glue-like tenacity, it is said. This property, together with its complete insolubility in gasoline, makes it suitable for use in pump and tank work, oil burner installations, bulk storage and refinery piping, or wherever petroleum oils are used or stored.

(12) *BJ elevator*

Designed to handle 20,000 ft. strings of 4½-in. externally upset drill pipe, the new MGG elevator of Byron Jackson Company has a capacity of 200 tons with a safety factor of 4 to 1. Basically similar in construction to BJ's type G elevator, which the company says has never dropped a string of pipe, the MGG has been heavied up throughout to take the increased load of the longest strings of pipe. To minimize the wedging action that takes place in handling long heavy strings of externally upset drill pipe, the seating taper of this elevator is contained within the body rather than on the top bore.

A heavy stirrup-type center latch that cannot be opened accidentally fits over

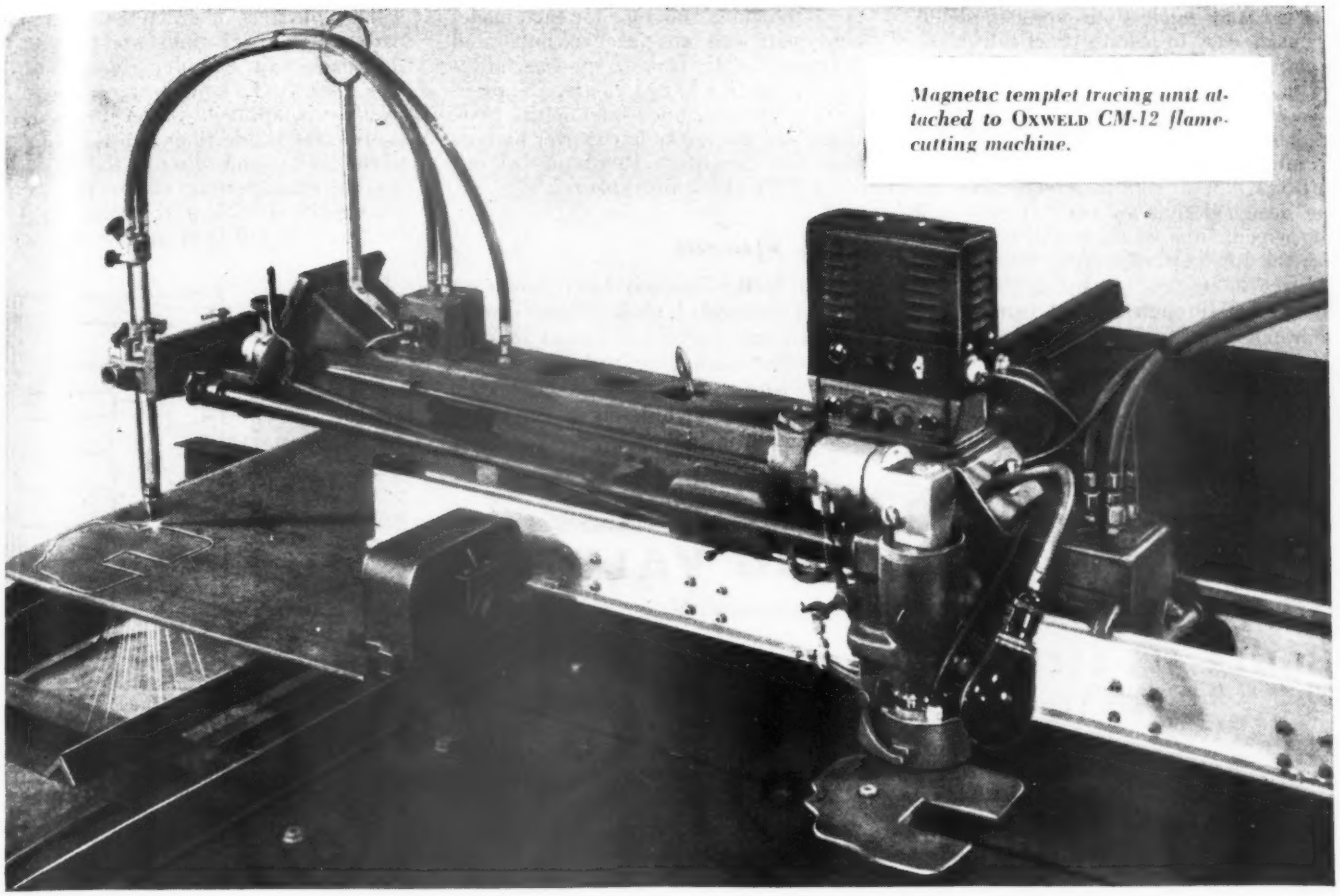


a heavy lug on the door. A latch lock is provided that serves to hold the latch securely in place and as a handle when opening. The latch lock must be moved through an arc of approximately 30 deg. before the latch can be released, then a continuing movement of the latch lock completes the opening of latch.

To insure always bringing elevator to the derrick man in a level position, an oil resistant synthetic rubber balancing strap is recommended. This strap is sold as an accessory.

(13) *Sucker rod wiper*

Patterson-Ballagh's sucker rod wipers are made in two styles, the regular Universal style and the Paraffin Remover style. These wipers offer effective means of completely stripping the rods



Magnetic templet tracing unit attached to OXWELD *CM-12 flame-cutting machine.*

MINIMIZE MACHINING ON SHAPE-CUT PARTS

Use Magnetic Tracers on OXWELD Flame-Cutting Machines

OXWELD magnetic tracers automatically guide the oxy-acetylene blowpipe to produce identical shapes time after time. These tracers follow templets of any shape—even with 90-degree corners—without deviation. Templets can be finish-machined to exact dimensions, and because they are made of steel, they retain their accuracy on quantity runs. OXWELD magnetic tracers are simple in their operation... a magnetic roller, following the prepared templet, drives the machine at a uniform controlled speed.

If you use an OXWELD CM-12, CM-15, or CM-23 flame-cutting machine, you can obtain a magnetic tracing unit for it. If you are considering a new machine for repetitive cutting of complicated parts with close tolerances, or if you are now shaping metal parts by another method, you should investigate the advantages of an OXWELD machine equipped for magnetic tracing. Complete information on making templets is supplied with each unit.

Write to any Linde office for additional information.

BUY AND HOLD UNITED STATES VICTORY BONDS AND STAMPS

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC **Offices in Other Principal Cities**

In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD, UNIONMELT APPARATUS
OXWELD AND UNIONMELT SUPPLIES

The words "Linde," "Oxweld," "Prest-O-Lite," "Prest-O-Weld," "Purox," "Union," and "Unionmelt" are trade-marks of Union Carbide and Carbon Corporation or its Units.

of oil and mud. Both are completely housed, easy to install, practically automatic in operation, and are available with either plain head or safety cap style head.

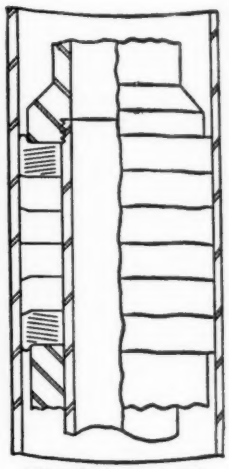
The wiping is done by self-aligning, reinforced disks of tough, wear-resisting PBX synthetic rubber. These disks are so designed that all sizes of rods will be wiped, from $\frac{5}{8}$ in. to $1\frac{1}{8}$ in. even if on the same string, and as the opening is free to stretch, the pump itself may be pulled through without injury. The Paraffin Remover style, illustrated, has two side outlets for the discharge of the excess paraffin, removed by the special cone-shaped refill that is situated just at the junction of the two outlets. There are two interchangeable tops for each model equipped with special eye bolts and "hammer" nuts, making quick removal easy by use of a hammer only. The plain cover is recommended for low gas pressures, and the safety latch cover for medium gas pressures. Refills are of oil-proof PBX synthetic rubber.

(14) *Floseal*

Lane-Wells Company has introduced Floseal integrated packer ring system for Olympic packers, designed to provide better packer control and easier, more positive operation under the high temperatures and differential pressures encountered in today's deeper wells.

The physical characteristics of the matched pairs of rings are graded so that each pair of outer rings confines and seals the flow of the inner rings as loading is applied. Under progressive loading the inside rings expand first until the load is picked up by the adjacent outside pair. Setting of the packer is accomplished with a minimum weight yet the seal will hold against high differential pressures and high temperatures, it is stated.

Detail of Floseal packer ring assembly for Olympic packers.



Floseal ring assembly under full loading. Note minimum extrusion.

The development of the Floseal packer ring material is the result of 52 comparative performance tests of different ring constructions under high temperature and pressure. The Floseal test was terminated after 2496 hours at 300°F. and 4000-lb. pressure because no additional extrusion or loss of pressure was noted. This indicated that the test could perhaps be continued for many months without noticeable effect upon the pack-off properties of the ring assembly.

Lane-Wells Company, 5610 South Soto Street, Los Angeles, California, is the manufacturer.

(15) *Tube gage*

Development of a new type gage designed to speed up accurate selection and sorting of tubes is announced by Airetool Manufacturing Company, Springfield, Ohio.

The gages are offered in kits consisting of 5 graduated gages with a total range from ½ in.-12 gage to 1 in.-16 gage. Each unit has 5 steps, each step providing a different gage. For example, the ½ in. begins with 12 gage and then increases through 13, 14, 16, and 18 gages.

Stocks mixed up in storage racks may be quickly separated and the tube size accurately determined by inserting the nearest size gage into the tube and pushing it until it stops. This method, the company announcement suggests, will save time when tubes of various gage are being assembled or selected.

HAMER PLUG VALVES

HAMER ALL STEEL REGULAR TYPE PLUG VALVES

150 lb. and 300 lb. Types

An economical valve for standpipe and standpipe manifolds in refineries, gasoline and process plants. It has the exclusive Hamer plug adjusting nut under the head, which gives positive control of the plug under all conditions. Chrome plated to resist turning friction, but is available in other types of surfacing, if chrome is not desired. Designed for either lubricated or non-lubricated use. Sizes: 1½", 2", 2½", 3", 4". Write for new engineering bulletin.

MODEL No. S30S

Series 300 Screw End Valve; used also for Series 150 Service. Working pressure 600 lbs.; Test pressure 1200 lbs.

MODEL No. FS30

Flanged, Series 150 and 300. Working pressure 600 lbs.; Test pressure 1200 lbs.

HAMER

REPUBLIC ELECTRIC WELD LINE PIPE

It's Republic's *improved* process of electric resistance welding . . . a process in which tremendous electrical energy combines with pressure to fuse together the clean edges of a cold-formed tubular shape, thus producing sound pipe—*with a weld area proved fully as strong as any other point in the wall.*

In thousands of tests, many conducted by independent, impartial research laboratories, Republic Electric Weld Line Pipe *repeatedly* has demonstrated its ability to withstand pressures far greater than those which might be encountered in the most severe service.

But there are other reasons, too, why more than 40,000 miles of Republic Electric Weld Line Pipe have gone into use throughout the oil and gas industries during the past 16 years.

This *modern* line pipe is *clean.* Because it is free from rolled-in scale, there is no danger of pipe failure due to inner surface sections breaking loose and leaving thin, weak spots in the wall.

Many cost-wise oil country men prefer Republic Line Pipe because it goes in the ground fast. Its consistently uniform *Straightness, Roundness* and *Wall Thickness*—its uniformly high *Ductility* and *Weldability* speed up bending and joining operations and enable crews to maintain schedules.

NOW is the time to investigate fully these and the many other advantages of *dependable* Republic Electric Weld Line Pipe. Write directly to:

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

INSPECTED INSIDE AND OUT

Republic Electric Weld Line Pipe is made from highest quality flat-rolled steel, both sides of which are open to close visual inspection. Thus, the surface which becomes the inside wall when formed into pipe is free from hidden defects.

REPUBLIC
LINE PIPE
NORMALIZED CASING AND TUBING

TRADE LITERATURE

Publications listed are sent free upon request.

(16) *Superior engines*

The Superior Engine Division of The National Supply Company has issued three bulletins describing and illustrating its equipment. Bulletin No. 4505-S is devoted to medium speed diesel generator sets and power units. Stationary diesel engines are described in Bulletin No. 4506-S, and Marine diesel engines in Bulletin No. 4508-M.

(17) *Thermo-control fan*

Evans Products Company, Detroit, Michigan, has issued a booklet on its thermo-control fan, used for automatic precision control of coolants in internal-combustion engines. The booklet is written in a "question and answer" form based on inquiries received from the field.

(18) *Multiple-engine power units*

Detroit Diesel Engine Division of General Motors Corporation has issued the first literature on its line of multiple-engine power units. The units embody high horsepower and extremely low weight. The bulletins are illustrated with diagrams of the units and performance curves.

(19) *History of Byron Jackson Company*

"Horizons—A study in transition, a future perspective" is the title of handsomely printed and excellently written booklet of 72 pages issued by the Byron Jackson Company of Los Angeles, California. This is a history of the company and is of considerable interest from that point of view. It will also be of interest to many because of illustrations showing some of the early day types of equipment.

(20) *Packing and gasket catalog*

Universal Packing & Gasket Company, Houston, Texas, has issued Catalog 45. The company states that its products fit the needs of every oilfield and industrial packing and gasket service, and is stocked by leading supply and industrial distributors. In addition to illustrative and descriptive material concerning its products, the catalog also contains a number of useful tables.

(21) *Hose assemblies*

Aeroquip Corporation, Jackson, Michigan, has issued a new industrial bulletin, No. 104, on its medium pressure hose assemblies. These assemblies are a departure in flexible tubing, according to the manufacturer. The hose lines are used with air, mineral, and vegetable base hydraulic fluids, deicing fluids, gasoline, lubricating oil, crude and fuel oils, water, glycol, ammonia, and cutting oils at temperatures ranging from minus 65°F. to plus 250°F.

(22) *An-cor-lox lock nuts*

A comprehensive folder on An-cor-lox Lock Nuts has been issued by the manufacturers, An-cor-lox Division, Laminated Shim Company Incorporated, Union Street, Glenbrook, Connecticut. This new lock nut is fully described in the folder. It is replete with diagrammatic, photographic, and factual matter on An-cor-lox styles, materials, designs and finishes; application instructions, and suggestions for parts conversion to the An-cor-lox function.

(23) *Bearing engineering*

A 270-page technical book entitled "Ball and Roller Bearing Engineering" has been published by SKF, Philadelphia, Pennsylvania, to serve as a fundamental text on all phases of bearing applications to industry.

The book, a bound volume containing some 900 drawings and tables, begins with a technical description of common bearing types and continues through 9 chapters of fundamental engineering studies.

(24) *Chemical, process equipment*

Ingersoll-Rand Company announces the publication of a new 16-page catalog entitled, "Equipment for Chemical and Process Plants." This two color bulletin is illustrated with many installation views of the company's products as they are used in such plants. The compressor section displays machines ranging from the small, air-cooled "Type 30" to the large 3000-hap. "PRE" models. Special purposes such as high pressure, refrigeration, and those requiring non-lubricated cylinders are featured. Reciprocating vacuum pumps are represented also.

Motor and turbo blowers, for lower pressures and large volumes of gas and air, are mentioned in their relation to the industries treated.

There are several pages of centrifugal pumps for all services in chemical and process plants, from small tank circulators, through single and multi-stage general service pumps, to the large vertical pump of 75,000-gal.-per-min. capacity.

Several cross-sections and schematic drawings in color show the workings of ejectors, barometric condensers, and the process of water-vapor refrigeration in a clear, instructive manner.

Representative diesel and gas engines for power service are pictured and the catalog is rounded out with a number of air tools and air hoists for general maintenance, construction, and production.

(25) *Extraction steam heaters*

An informative bulletin on Extraction Steam Heaters has been prepared by The Griscom-Russell Company. The bulletin describes and illustrates extraction heaters of both horizontal and vertical types, for high, medium, and low pressures. Numerous cross-section diagrams graphically explain operation as well as construction. The distinctive advantages that are described include the G-R exclusive visible pressure seal of breech-block heads, self-adjusting compression ring gaskets, partition pass plates to prevent leakage between passes without use of stay bolts, enveloping steam baffle that permits cross-over temperatures, and removable air baffle with sub-cooling action.

(26) *Dow Corning silicones*

A new catalog listing all Dow Corning Corporation silicone products is now available. The booklet contains many charts and graphs demonstrating the unusual properties of this rapidly increasing family of organo-silicon-oxide polymers.

Dow Corning silicones are produced in many forms including fluids, greases and compounds, resins and varnishes, and silastic, the Dow Corning silicone rubber. In all their forms the silicones extend permissible operating temperatures far above and below those at which comparable organic materials are serviceable, the manufacturer states.

All these main classes of silicone products and many special formulations among each of them are described.

(27) *The Silbraz joint*

The Silbraz Joint—the modern threadless connection that actually bonds I.P.S. copper tubing and brass pipe into a single "one-piece" pipe line—is thoroughly described in Airco's new 16-page, 2-color booklet: "How to Cash in on the Silver Ring." Profusely illustrated, the booklet shows how Silbraz joints are made from patented bronze pipe fittings, valves, and flanges—containing a factory inserted ring of silver brazing alloy in each port opening.

(28) *Roller chain belts*

An 8-page folder on Baldwin-Rex roller chain belts is being distributed by the Baldwin-Duckworth Division of The Chain Belt Company. A detailed description of the roller chain features is presented. This, together with a table of specifications of the more popular sizes with their list prices, makes this folder a handy reference piece.

(29) *Metric reset controller*

American Meter Company has published its technical descriptive Bulletin E-24, on the new Metric Reset Controller. Photographs and descriptions of the five interchangeable major subassemblies comprising this instrument are included, together with a cross-sectional drawing showing in color the functions of these parts in the operation of the controller.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 101

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue, and 98-100, inclusive, in the October, 1945, issue.

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Hyatt Bearings Division, General Motors Corp.	(sheet 3)	268	Nov.	P 680.2
Maxim Silencer Co.	(sheet 7)	264	Nov.	P 778.3
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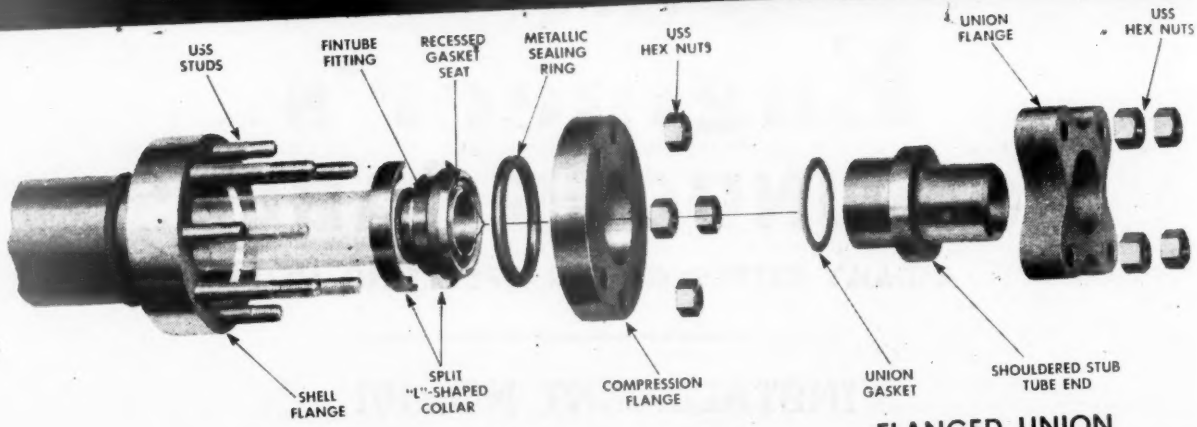
THIS EFFICIENT HEAD END ASSEMBLY



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Send today for the fully descriptive catalog, and let our engineers help you in adapting Brown Fintube Sectional Heat Exchangers to your exact and individual requirements.

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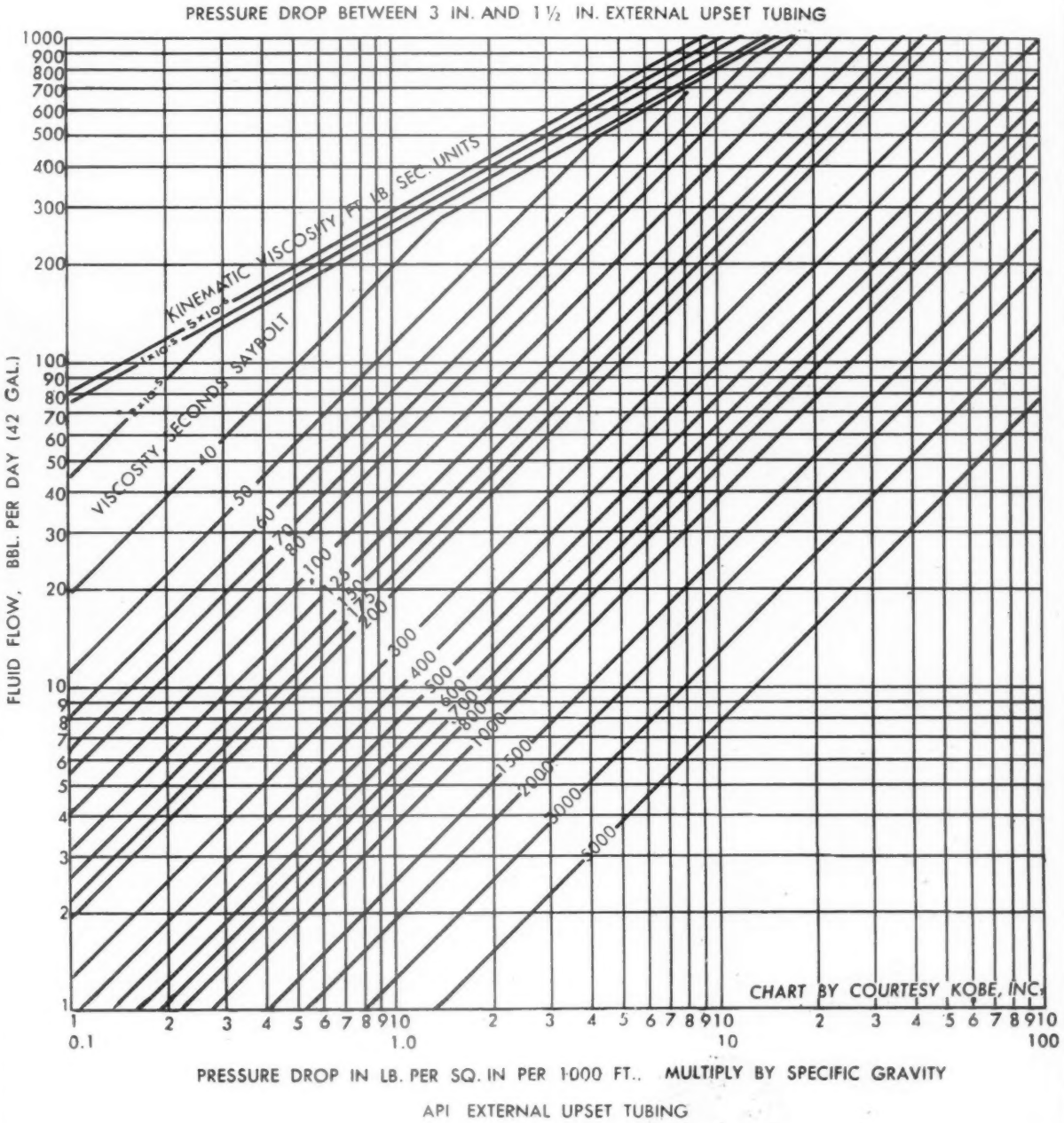
PRESSURE DROP CALCULATION CHARTS



Note: This chart is not applicable in cases where gas is present in sufficient quantity to break out of solution, or where the fluid characteristics are not uniform.

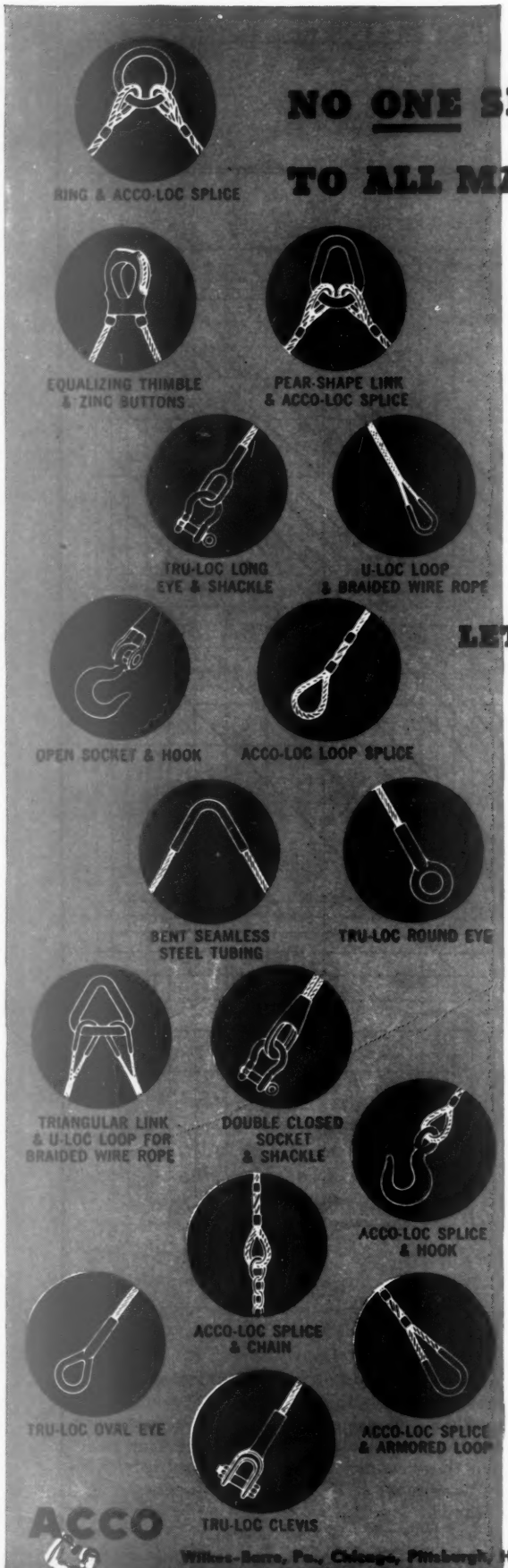
Example:

Given: Rate of flow = 100 bbl. per day
Viscosity of fluid = 100 sec. Saybolt
Specific gravity = 0.82

Wanted: Pressure drop through 5000 ft. of annulus between 3-in. and 1½-in. API external upset tubing.

Solution: Beginning at the 100 bbl. per day point on the fluid flow scale follow the horizontal line to the right to the point where this line crosses the 100 viscosity-sec. Saybolt line. Continue straight downward from this point and read the pressure drop = 2.5 lb. Multiply this figure by 0.82 gravity. This gives the pressure drop per 1000 ft. under these conditions = 2.05 lb. Multiply the result by 5 (the number of 1000's of ft.). The answer is the result of the last multiplication:

The pressure drop = 10.25 lb. through 5000 ft. of annulus between 3-in. and 1½-in. E.U.E. tubing when the rate of flow is 100 bbl. per day, the viscosity. 100 sec. Saybolt, and the specific gravity 0.82.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TRU-LOC LONG EYE & SHACKLE
U-LOC LOOP & BRAIDED WIRE ROPE
OPEN SOCKET & HOOK
ACCO-LOC LOOP SPLICE
BENT SEAMLESS STEEL TUBING
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TRIANGULAR LINK & U-LOC LOOP FOR BRAIDED WIRE ROPE
DOUBLE CLOSED SOCKET & SHACKLE
ACCO-LOC SPLICE & HOOK
ACCO-LOC SPLICE & CHAIN
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3. Conventional wire rope sling . . . ?
4. Which of the many different terminals . . . ?

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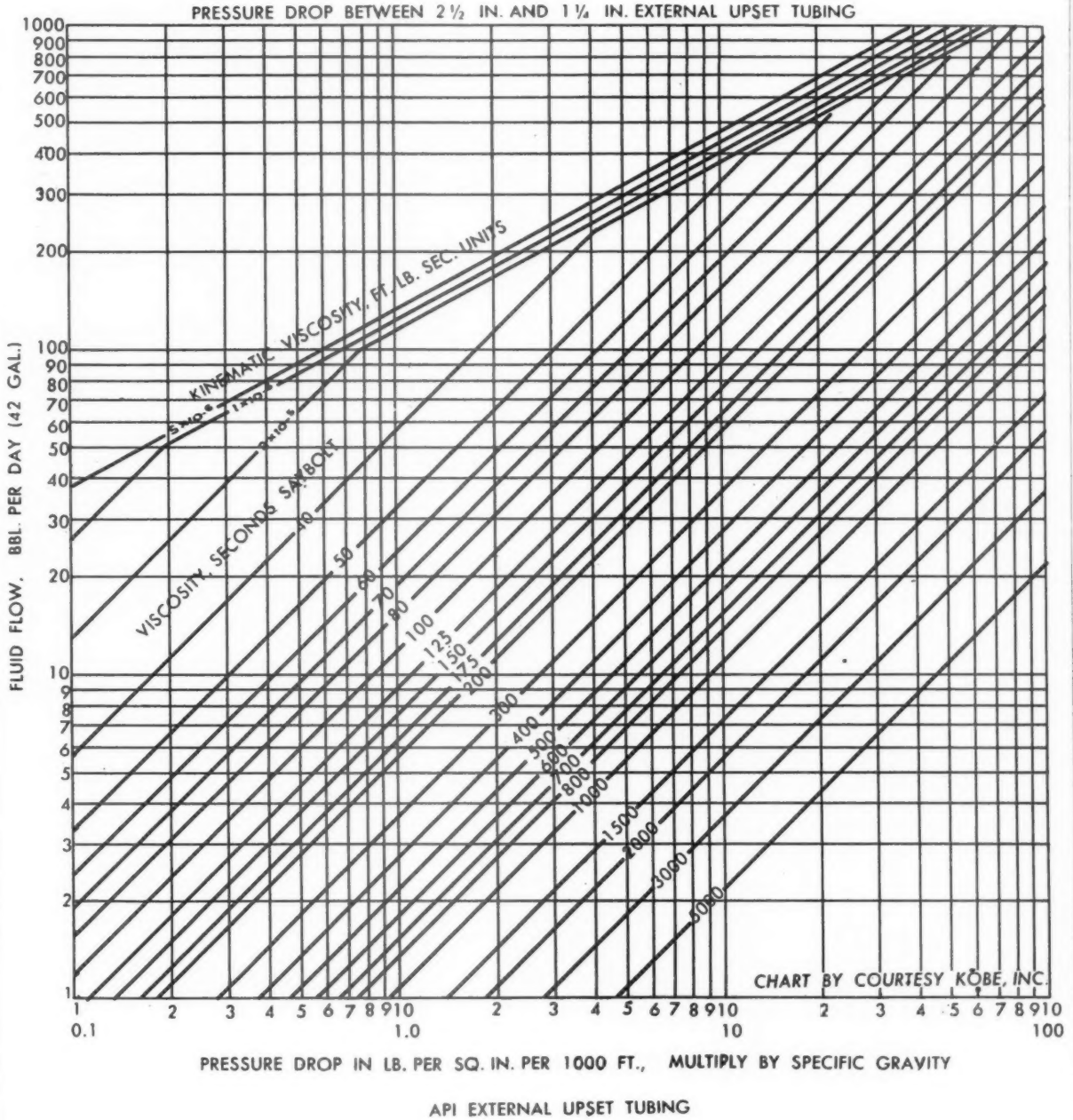
PRESSURE DROP CALCULATION CHARTS


PRESSURE DROP BETWEEN 2½ IN. AND 1¼ IN. EXTERNAL UPSET TUBING
FLUID FLOW, BBL. PER DAY (42 GAL.)
KINEMATIC VISCOSITY, FT. LB. SEC. UNITS
VISCOSITY, SECONDS SAYBOLT
CHART BY COURTESY KOBE, INC.
PRESSURE DROP IN LB. PER SQ. IN. PER 1000 FT., MULTIPLY BY SPECIFIC GRAVITY
API EXTERNAL UPSET TUBING

Note: This chart is not applicable in cases where gas is present in sufficient quantity to break out of solution, or where the fluid characteristics are not uniform.

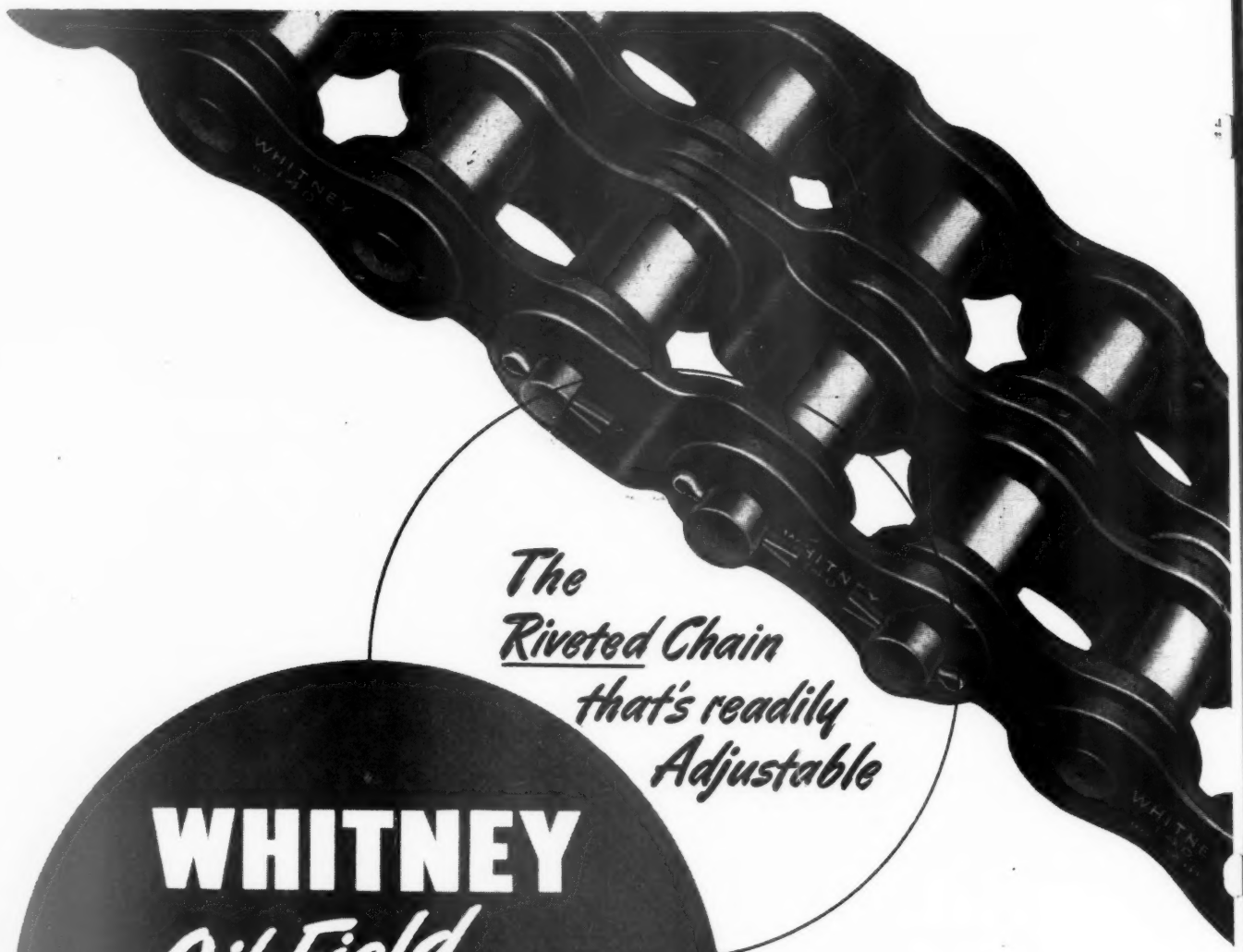
Example:

Given: Rate of flow = 100 bbl. per day
Viscosity of fluid = 100 sec. Saybolt
Specific gravity = 0.82

Wanted: Pressure drop through 5000 ft. of annulus between 2½-in. and 1¼-in. API external upset tubing.

Solution: Beginning at the 100 bbl. per day point on the fluid flow scale follow the horizontal line to the right to the point where this line crosses the 100 viscosity-sec. Saybolt line. Continue straight downward from this point and read the pressure drop = 8.5 lb. Multiply this figure by 0.82 gravity. This gives the pressure drop per 1000 ft. under these conditions = 6.97 lb. Multiply the result by 5 (the number of 1000's of ft.). The answer is the result of the last multiplication:

The pressure drop = 34.85 lb. through 5000 ft. of annulus between 2½-in. and 1¼-in. E.U.E. tubing when the rate of flow is 100 bbl. per day, the viscosity 100 sec. Saybolt, and the specific gravity 0.82.



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VAPOR PRESSURE BLENDING CURVES FOR COMMERCIAL BUTANE

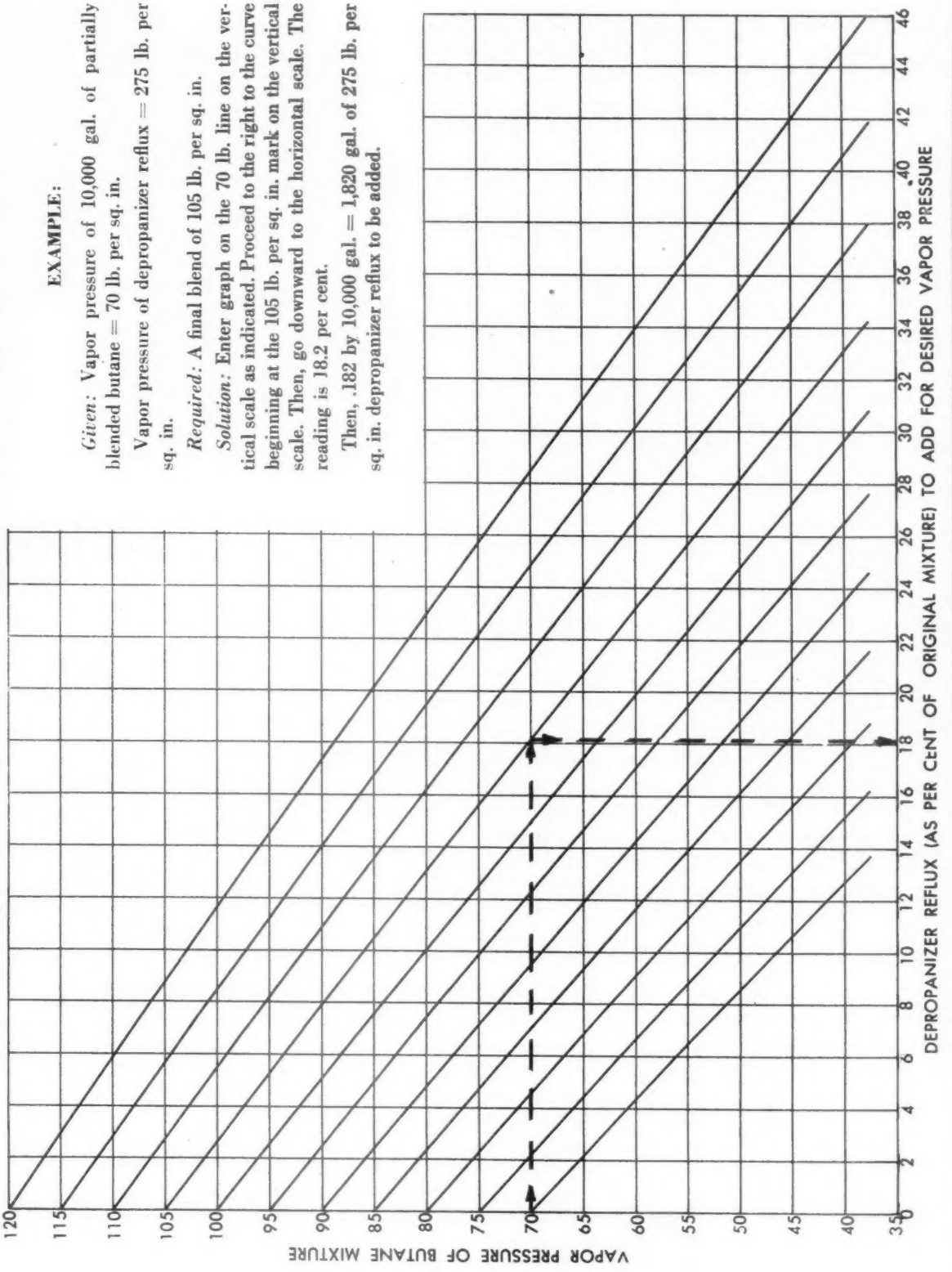


FIG. 6. Blending curves for butane mixture and depropanizer reflux of 275 lb. per sq. in. at 100°F.

EXAMPLE:

Given: Vapor pressure of 10,000 gal. of partially blended butane = 70 lb. per sq. in.

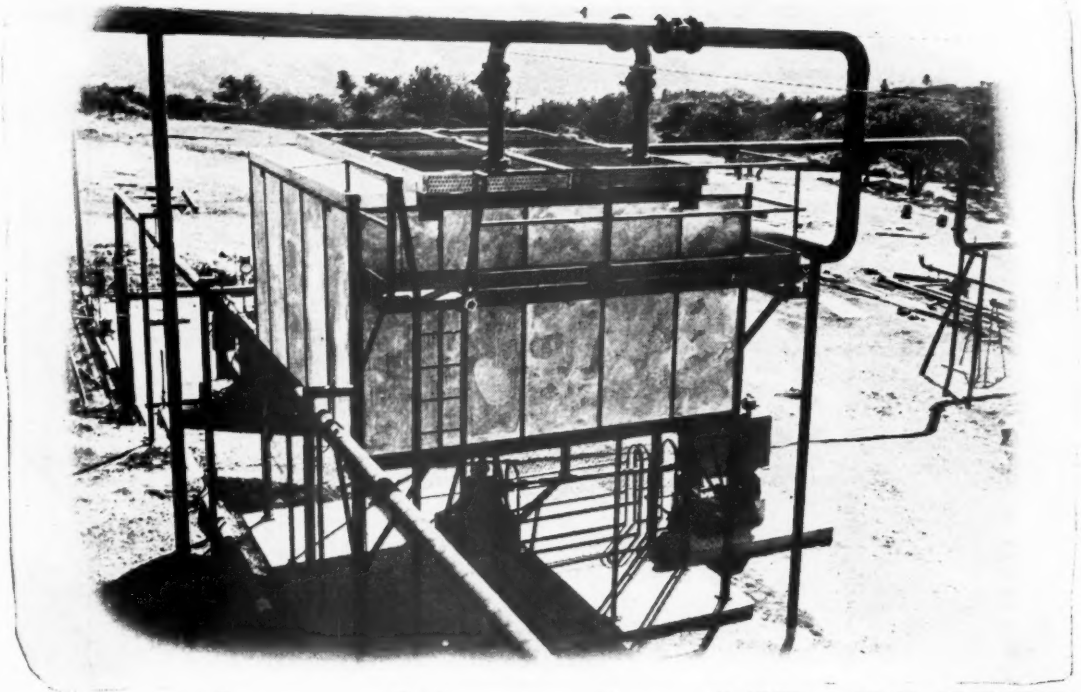
Vapor pressure of depropanizer reflux = 275 lb. per sq. in.

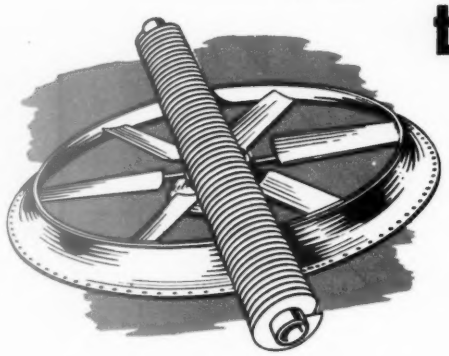
Required: A final blend of 105 lb. per sq. in.

Solution: Enter graph on the 70 lb. line on the vertical scale as indicated. Proceed to the right to the curve beginning at the 105 lb. per sq. in. mark on the vertical scale. Then, go downward to the horizontal scale. The reading is 18.2 per cent.

Then, .182 by 10,000 gal. = 1,820 gal. of 275 lb. per sq. in. depropanizer reflux to be added.

Investigate FIN-FAN





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- Oil cooling
- Compressed air cooling
- Solution cooling
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or a combination of one or more services with the same unit

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Pioneers in Heat Transfer Apparatus

SPECIFIC GRAVITY CORRECTION FACTORS FOR ORIFICE METERS

From \ To	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.73
0.60	1.0000	0.9918	0.9837	0.9759	0.9682	0.9608	0.9535	0.9463	0.9393	0.9325	0.9258	0.9193	0.9129	0.9066
0.61	1.0083	1.0000	0.9919	0.9840	0.9763	0.9687	0.9614	0.9542	0.9471	0.9402	0.9335	0.9269	0.9204	0.9141
0.62	1.0165	1.0082	1.0000	0.9920	0.9843	0.9766	0.9692	0.9620	0.9549	0.9479	0.9411	0.9345	0.9280	0.9216
0.63	1.0247	1.0163	1.0080	1.0000	0.9922	0.9845	0.9770	0.9697	0.9625	0.9555	0.9489	0.9420	0.9354	0.9290
0.64	1.0328	1.0243	1.0160	1.0079	1.0000	0.9923	0.9847	0.9774	0.9701	0.9631	0.9562	0.9494	0.9428	0.9363
0.65	1.0408	1.0323	1.0239	1.0158	1.0078	1.0000	0.9924	0.9850	0.8777	0.9706	0.9636	0.9568	0.9501	0.9436
0.66	1.0488	1.0402	1.0318	1.0235	1.0155	1.0077	1.0000	0.9925	0.9852	0.9780	0.9710	0.9641	0.9574	0.9508
0.67	1.0567	1.0480	1.0395	1.0313	1.0232	1.0153	1.0075	1.0000	0.9926	0.9854	0.9783	0.9714	0.9647	0.9580
0.68	1.0646	1.0585	1.0489	1.0389	1.0308	1.0228	1.0150	1.0074	1.0000	0.9927	0.9856	0.9786	0.9718	0.9651
0.69	1.0724	1.0636	1.0549	1.0465	1.0383	1.0303	1.0225	1.0148	1.0073	1.0000	0.9928	0.9858	0.9789	0.9722
0.70	1.0801	1.0713	1.0626	1.0541	1.0458	1.0377	1.0299	1.0221	1.0146	1.0072	1.0000	0.9929	0.9860	0.9792
0.71	1.0878	1.0789	1.0701	1.0616	1.0533	1.0451	1.0372	1.0294	1.0218	1.0144	1.0071	1.0000	0.9930	0.9862
0.72	1.0954	1.0864	1.0776	1.0690	1.0607	1.0525	1.0445	1.0366	1.0290	1.0215	1.0142	1.0070	1.0000	0.9931
0.73	1.1030	1.0940	1.0851	1.0764	1.0680	1.0597	1.0517	1.0438	1.0361	1.0286	1.0212	1.0140	1.0069	1.0000
0.74	1.1105	1.1014	1.0925	1.0838	1.0753	1.0670	1.0589	1.0509	1.0432	1.0356	1.0282	1.0209	1.0138	1.0068
0.75	1.1180	1.1088	1.0999	1.0911	1.0825	1.0742	1.0660	1.0580	1.0502	1.0426	1.0351	1.0278	1.0206	1.0136
0.76	1.1255	1.1162	1.1072	1.0983	1.0897	1.0813	1.0731	1.0650	1.0572	1.0495	1.0420	1.0346	1.0274	1.0203
0.77	1.1328	1.1235	1.1144	1.1055	1.0969	1.0884	1.0801	1.0720	1.0641	1.0564	1.0488	1.0414	1.0341	1.0270
0.78	1.1402	1.1308	1.1216	1.1127	1.1040	1.0954	1.0871	1.0790	1.0710	1.0632	1.0556	1.0481	1.0408	1.0337
0.79	1.1475	1.1380	1.1288	1.1198	1.1110	1.1024	1.0941	1.0859	1.0779	1.0700	1.0623	1.0548	1.0475	1.0403
0.80	1.1547	1.1452	1.1359	1.1269	1.1180	1.1094	1.1010	1.0927	1.0847	1.0768	1.0690	1.0615	1.0541	1.0469
0.81	1.1619	1.1523	1.1430	1.1339	1.1250	1.1163	1.1078	1.0995	1.0914	1.0835	1.0757	1.0681	1.0607	1.0534
0.82	1.1690	1.1594	1.1500	1.1409	1.1319	1.1232	1.1146	1.1063	1.1081	1.0901	1.0823	1.0477	1.0672	1.0599
0.83	1.1761	1.1665	1.1570	1.1478	1.1388	1.1300	1.1214	1.1130	1.1048	1.0968	1.0889	1.0812	1.0737	1.0663
0.84	1.1832	1.1735	1.1640	1.1547	1.1457	1.1368	1.1282	1.1197	1.1114	1.1034	1.0955	1.0877	1.0801	1.0727
0.85	1.1902	1.1804	1.1709	1.1615	1.1524	1.1435	1.1348	1.1263	1.1180	1.1099	1.1019	1.0942	1.0865	1 0791
0.86	1.1972	1.1874	1.1777	1.1684	1.1592	1.1502	1.1415	1.1329	1.1246	1.1164	1.1084	1.1006	1.0929	1.0854
0.87	1.2042	1.1943	1.1846	1.1751	1.1659	1.1569	1.1481	1.1395	1.1311	1.1229	1.1148	1.1070	1.0992	1.0917
0.88	1.2111	1.2011	1.1914	1.1819	1.1726	1.1635	1.1547	1.1460	1.1376	1.1293	1.1212	1.1133	1.1055	1.0979
0.89	1.2179	1.2079	1.1981	1.1886	1.1793	1.1701	1.1613	1.1525	1.1440	1.1357	1.1276	1.1196	1.1118	1.1042
0.90	1.2247	1.2147	1.2048	1.1952	1.1859	1.1767	1.1677	1.1590	1.1504	1.1421	1.1339	1.1259	1.1180	1.1103
0.91	1.2315	1.2211	1.2115	1.2018	1.1924	1.1832	1.1742	1.1654	1.1568	1.1484	1.1402	1.1321	1.1242	1.1165
0.92	1.2383	1.2282	1.2181	1.2084	1.1990	1.1897	1.1807	1.1718	1.1632	1.1547	1.1464	1.1383	1.1304	1.1226
0.93	1.2450	1.2348	1.2248	1.2150	1.2055	1.1961	1.1871	1.1782	1.1695	1.1610	1.1526	1.1445	1.1365	1.1287
0.94	1.2517	1.2414	1.2313	1.2215	1.2119	1.2026	1.1934	1.1845	1.1757	1.1672	1.1588	1.1506	1.1426	1.1348
0.95	1.2583	1.2480	1.2378	1.2280	1.2184	1.2089	1.1998	1.1908	1.1820	1.1734	1.1650	1.1567	1.1487	1.1408
0.96	1.2649	1.2545	1.2443	1.2344	1.2248	1.2153	1.2061	1.1970	1.1882	1.1795	1.1711	1.1628	1.1547	1.1468
0.97	1.2715	1.2610	1.2508	1.2408	1.2311	1.2216	1.2123	1.2032	1.1944	1.1857	1.1772	1.1689	1.1607	1.1527
0.98	1.2780	1.2675	1.2572	1.2472	1.2374	1.2279	1.2185	1.2094	1.2005	1.1918	1.1832	1.1749	1.1667	1.1586
0.99	1.2845	1.2740	1.2636	1.2536	1.2437	1.2341	1.2248	1.2156	1.2066	1.1978	1.1892	1.1808	1.1726	1.1645
1.00	1.2910	1.2804	1.2700	1.2599	1.2500	1.2403	1.2309	1.2217	1.2127	1.2039	1.1952	1.1868	1.1785	1.1704

FORMULA: $\frac{\sqrt{\text{old gravity}}}{\sqrt{\text{new gravity}}}$ = Multiplier (correction factor)

EXAMPLE OF COMPUTATION: To correct from a gravity of 0.60 to 0.70:

$$\frac{\sqrt{0.600}}{\sqrt{0.700}} = \frac{0.7746}{0.8367} = 0.9258 \text{ (as shown above on 0.60 line under 0.70)}$$

NOTE: The multipliers in these tables may be used in conjunction with orifice meter coefficients such as *The Petroleum Engineer's* table P 683.320.3, entitled "One Hour Coefficient at Various Pressure Bases," published in June, 1943. Multiplication of any of those coefficients (based on 0.60 gravity gas) by the multiplier in the first line above that corresponds to the actual gravity of the gas being measured through an orifice plate will properly correct the coefficient for use in calculating the actual volume.

EXAMPLE OF USE: The one hour coefficient for a 4 x ¼-in. plate with flange connections in a 4.026 I.D. pipe = 16.6 (for 14.4 lb. plus 4 oz. abs. pressure base, 0.60 gravity, and 60°F. temperature).

Then, for correction from 0.60 to 0.70 gravity, multiply 16.6 by 0.9258 (under 0.70 and on the 0.60 line above) = 15.368 (corrected one hour coefficient.)

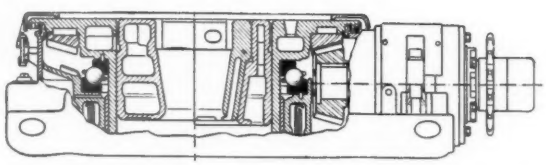
STEPPING UP ROTARY TABLE SPEEDS

The need for faster oil production and the tremendous loads imposed by present day deep drilling make it imperative that oil field equipment, such as this fast-turning Ideco Streamlined Rotary, be more rugged and efficient than ever before. The Torrington Angular Contact Bearing with which the Ideco Rotary is equipped is specifically designed for long, trouble-free service life at high rotating speeds.

The rigidly controlled hardening and grinding processes enable these bearings to withstand unusually high radial and thrust loads with a minimum of wear, and assure equalized load distribution and utmost precision under all service conditions.

The ability of Torrington's Bantam Bearings Division to solve routine or unusual anti-friction problems quickly is a result of long experience in the design and manufacture of custom-built bearings for pumping units, crown blocks, rotary swivels and other heavy-duty oil field equipment. We invite you to consult with our engineers on any of your bearing problems.

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA



Shown above is a cutaway view of the Torrington Angular Contact Bearing, and X-section drawing indicating its position in the Ideco Streamlined Rotary. Torrington Bearings are widely used in oil field equipment and in many other types of heavy-duty machinery.

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

VAPOR PRESSURE BLENDING CURVES FOR COMMERCIAL BUTANE

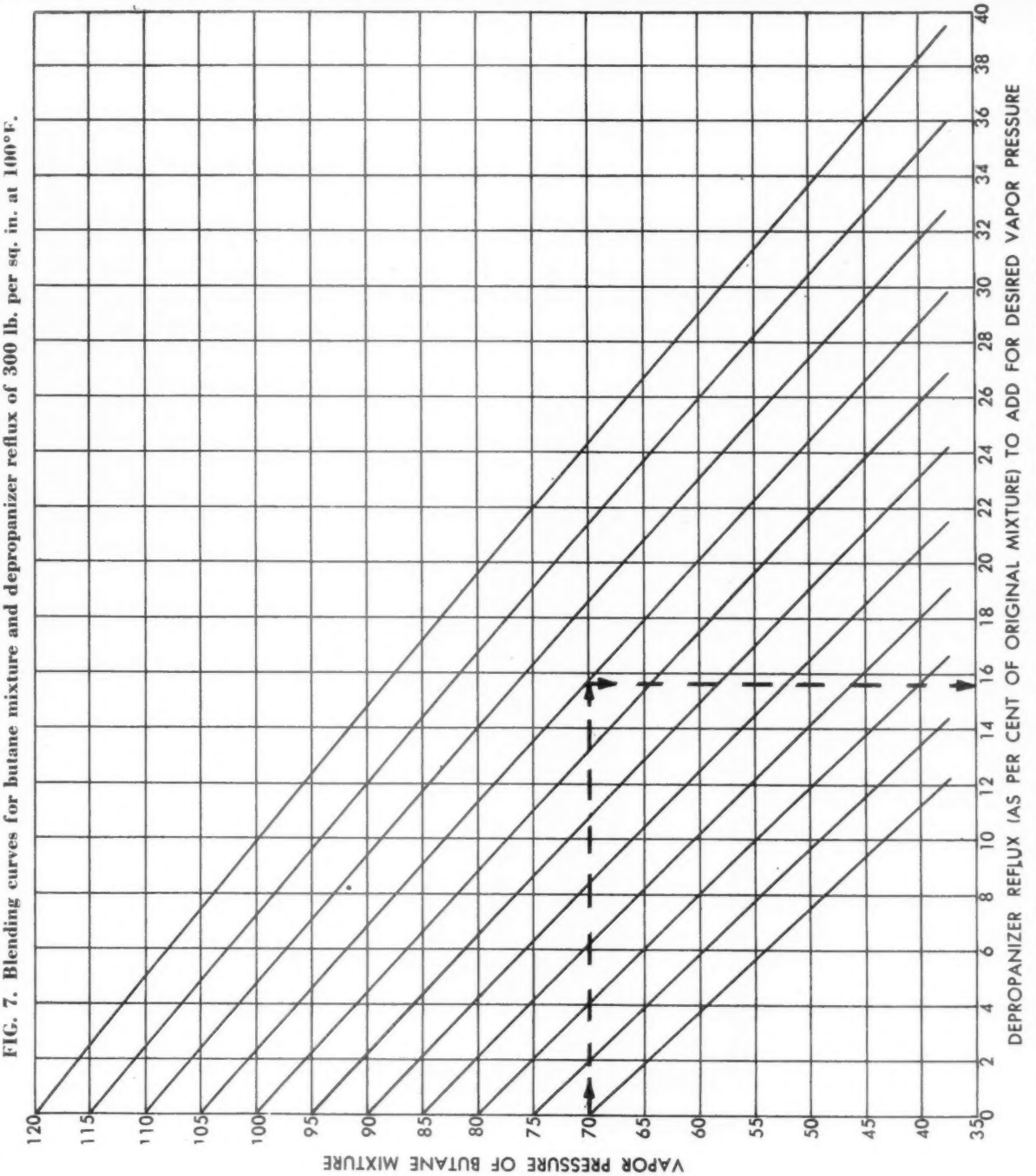


FIG. 7. Blending curves for butane mixture and depropanizer reflux of 300 lb. per sq. in. at 100°F.

EXAMPLE:

Given:

Vapor pressure of 10,000 gal. of partially blended butane = 70 lb. per sq. in.

Vapor pressure of depropanizer reflux = 300 lb. per sq. in.

Required:

A final blend of 105 lb. per sq. in.

Solution:

Enter graph on the 70 lb. line on the vertical scale as indicated. Proceed to the right to the curve beginning at the 105 lb. mark on the vertical scale. Then, go downward to the horizontal scale. The reading is 15.6 per cent.

Then, .156 by 10,000 gal. = 1560 gal of 300 lb. per sq. in. depropanizer reflux to be added.

SAVE FUEL

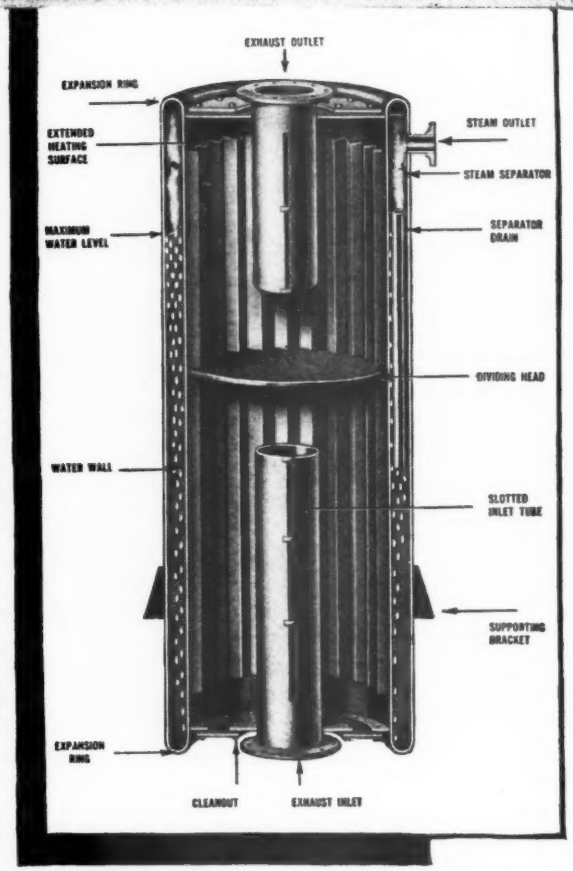
PUT EXHAUST HEAT TO WORK WITH

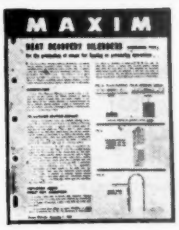
MAXIM HEAT RECOVERY SILENCERS

There are few industrial plants that would knowingly throw away fuel, and yet many do just that when they allow engine exhaust heat to escape without making use of it. Maxim Heat Recovery Silencers utilize exhaust heat to produce steam or hot water for heating or processing operations. They combine in one unit effective silencing of exhaust noise, spark arresting (where necessary) and efficient heat recovery.

From an efficiency point of view, the value of using Maxim Heat Recovery Silencers is obvious. Engine exhaust must be silenced as a matter of good public relations. The use of Heat Recovery Silencers accomplishes this and, in addition, produces "fuel-free" steam or hot water.

For silencing without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.





Write for Bulletin

Bulletin WH-101 is an eight page illustrated folder showing various types of heat recovery silencers and also practical working hook-ups. A copy will be sent promptly on request.

THE MAXIM SILENCER COMPANY • **90 HOMESTEAD AVE., HARTFORD, CONN.**

ARMY E NAVY

MAXIM

SPECIFIC GRAVITY CORRECTION FACTORS FOR ORIFICE METERS

From	To 0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87
0.60	0.9005	0.8944	0.8885	0.8827	0.8771	0.8715	0.8660	0.8607	0.8554	0.8502	0.8452	0.8402	0.8353	0.8305
0.61	0.9079	0.9018	0.8959	0.8901	0.8843	0.8787	0.8732	0.8678	0.8625	0.8573	0.8522	0.8471	0.8422	0.8373
0.62	0.9153	0.9092	0.9032	0.8973	0.8916	0.8859	0.8803	0.8749	0.8695	0.8643	0.8591	0.8541	0.8491	0.8442
0.63	0.9227	0.9165	0.9105	0.9045	0.8987	0.8930	0.8874	0.8819	0.8765	0.8712	0.8660	0.8609	0.8559	0.8510
0.64	0.9300	0.9238	0.9177	0.9117	0.9058	0.9001	0.8944	0.8889	0.8835	0.8781	0.8729	0.8677	0.8627	0.8577
0.65	0.9372	0.9309	0.9248	0.9188	0.9120	0.9071	0.9014	0.8958	0.8903	0.8850	0.8797	0.8744	0.8694	0.8644
0.66	0.9444	0.9381	0.9319	0.9258	0.9199	0.9140	0.9083	0.9027	0.8971	0.8917	0.8864	0.8812	0.8760	0.8710
0.67	0.9515	0.9452	0.9389	0.9328	0.9268	0.9209	0.9152	0.9095	0.9039	0.8985	0.8931	0.8878	0.8827	0.8776
0.68	0.9586	0.9522	0.9459	0.9397	0.9337	0.9278	0.9220	0.9162	0.9106	0.9051	0.8997	0.8944	0.8892	0.8841
0.69	0.9656	0.9592	0.9528	0.9466	0.9405	0.9346	0.9287	0.9230	0.9173	0.9118	0.9063	0.9010	0.8957	0.8906
0.70	0.9726	0.9661	0.9597	0.9535	0.9473	0.9413	0.9354	0.9296	0.9239	0.9184	0.9128	0.9075	0.9022	0.8970
0.71	0.9795	0.9730	0.9665	0.9602	0.9541	0.9480	0.9421	0.9362	0.9305	0.9249	0.9194	0.9139	0.9086	0.9034
0.72	0.9864	0.9798	0.9733	0.9670	0.9608	0.9547	0.9487	0.9428	0.9370	0.9314	0.9258	0.9204	0.9150	0.9097
0.73	0.9932	0.9866	0.9801	0.9737	0.9674	0.9613	0.9552	0.9493	0.9435	0.9378	0.9322	0.9267	0.9213	0.9160
0.74	1.0000	0.9933	0.9868	0.9803	0.9740	0.9678	0.9618	0.9558	0.9500	0.9442	0.9386	0.9331	0.9276	0.9223
0.75	1.0067	1.0000	0.9934	0.9869	0.9806	0.9744	0.9682	0.9623	0.9564	0.9506	0.9449	0.9393	0.9339	0.9285
0.76	1.0134	1.0066	1.0000	0.9935	0.9871	0.9808	0.9747	0.9686	0.9627	0.9569	0.9512	0.9456	0.9401	0.9346
0.77	1.0201	1.0132	1.0066	1.0000	0.9936	0.9873	0.9811	0.9750	0.9690	0.9632	0.9574	0.9518	0.9462	0.9408
0.78	1.0267	1.0198	1.0131	1.0065	1.0000	0.9937	0.9874	0.9813	0.9753	0.9694	0.9636	0.9579	0.9523	0.9469
0.79	1.0332	1.0263	1.0195	1.0129	1.0064	1.0000	0.9937	0.9876	0.9815	0.9756	0.9697	0.9641	0.9584	0.9529
0.80	1.0398	1.0328	1.0260	1.0193	1.0127	1.0063	1.0000	0.9938	0.9877	0.9818	0.9759	0.9701	0.9645	0.9589
0.81	1.0462	1.0392	1.0324	1.0256	1.0190	1.0126	1.0062	1.0000	0.9939	0.9879	0.9820	0.9762	0.9705	0.9649
0.82	1.0527	1.0456	1.0387	1.0320	1.0253	1.0188	1.0124	1.0062	1.0000	0.9940	0.9880	0.9822	0.9765	0.9708
0.83	1.0591	1.0520	1.0450	1.0382	1.0315	1.0250	1.0186	1.0123	1.0061	1.0000	0.9940	0.9882	0.9824	0.9767
0.84	1.0654	1.0583	1.0513	1.0445	1.0377	1.0312	1.0247	1.0184	1.0121	1.0060	1.0000	0.9941	0.9883	0.9826
0.85	1.0717	1.0646	1.0575	1.0507	1.0439	1.0373	1.0308	1.0244	1.0181	1.0120	1.0059	1.0000	0.9942	0.9884
0.86	1.0780	1.0708	1.0638	1.0568	1.0500	1.0434	1.0368	1.0304	1.0241	1.0179	1.0118	1.0059	1.0000	0.9942
0.87	1.0843	1.0770	1.0699	1.0630	1.0561	1.0494	1.0428	1.0364	1.0300	1.0238	1.0177	1.0117	1.0058	1.0000
0.88	1.0905	1.0832	1.0761	1.0690	1.0622	1.0554	1.0488	1.0423	1.0359	1.0297	1.0235	1.0175	1.0116	1.0057
0.89	1.0967	1.0893	1.0822	1.0751	1.0682	1.0614	1.0547	1.0482	1.0418	1.0355	1.0293	1.0233	1.0173	1.0114
0.90	1.1028	1.0954	1.0882	1.0811	1.0742	1.0673	1.0607	1.0541	1.0476	1.0413	1.0351	1.0290	1.0230	1.0171
0.91	1.1089	1.1015	1.0942	1.0871	1.0801	1.0733	1.0665	1.0599	1.0534	1.0471	1.0408	1.0347	1.0287	1.0227
0.92	1.1150	1.1075	1.1002	1.0931	1.0860	1.0791	1.0724	1.0657	1.0592	1.0528	1.0465	1.0404	1.0343	1.0283
0.93	1.1211	1.1136	1.1062	1.0990	1.0919	1.0850	1.0782	1.0715	1.0650	1.0595	1.0522	1.0460	1.0399	1.0339
0.94	1.1271	1.1195	1.1121	1.1049	1.0978	1.0908	1.0840	1.0773	1.0707	1.0642	1.0578	1.0516	1.0455	1.0395
0.95	1.1330	1.1255	1.1180	1.1107	1.1036	1.0966	1.0897	1.0830	1.0764	1.0699	1.0635	1.0571	1.0510	1.0450
0.96	1.1390	1.1314	1.1239	1.1166	1.1094	1.1024	1.0954	1.0887	1.0820	1.0755	1.0690	1.0627	1.0565	1.0505
0.97	1.1449	1.1372	1.1297	1.1224	1.1152	1.1081	1.1011	1.0943	1.0876	1.0811	1.0746	1.0683	1.0620	1.0559
0.98	1.1508	1.1431	1.1356	1.1281	1.1209	1.1138	1.1068	1.0999	1.0932	1.0866	1.0801	1.0738	1.0675	1.0613
0.99	1.1567	1.1489	1.1413	1.1339	1.1266	1.1195	1.1124	1.1055	1.0988	1.0921	1.0856	1.0792	1.0729	1.0667
1.00	1.1625	1.1547	1.1471	1.1396	1.1323	1.1251	1.1180	1.1111	1.1043	1.0976	1.0911	1.0847	1.0783	1.0721

FORMULA: $\frac{\sqrt{\text{old gravity}}}{\sqrt{\text{new gravity}}}$ = Multiplier (correction factor)

EXAMPLE OF COMPUTATION: To correct from a gravity of 0.60 to 0.80:

$$\frac{\sqrt{0.600}}{\sqrt{0.800}} = \frac{0.7746}{0.8944} = 0.8660 \text{ (as shown above on 0.60 line under 0.80)}$$

NOTE: The multipliers in these tables may be used in conjunction with orifice meter coefficients such as *The Petroleum Engineer's* table P 683.320.3, entitled "One Hour Coefficient at Various Pressure Bases," published in June, 1943. Multiplication of any of those coefficients (based on 0.60 gravity gas) by the multiplier in the first line above that corresponds to the actual gravity of the gas being measured through an orifice plate will properly correct the coefficient for use in calculating the actual volume.

EXAMPLE OF USE: The one hour coefficient for a 4 x ¼-in. plate with flange connections in a 4.026 I.D. pipe = 16.6 (for 14.4 lb. plus 4 oz. absolute pressure base, 0.60 gravity, and 60°F. temperature).

Then, for correction from 0.60 to 0.80 gravity, multiply 16.6 by 0.8660 (under 0.80 and on the 0.60 line above) = 14.375 (corrected one hour coefficient).

It's the Nash!

Nash Compressors in your plant can automatically increase the capacity of your absorption equipment, for with the Nash it is possible to secure absorption directly in the pump.

This is due to the Nash liquid compressant operating principle, involving a fluid vortex through which the gas must pass in the process of compression. To absorb from a gas, simply flow absorbent through the compressor as the compressing medium. In this close contact of liquid and gas, the desired fractions are picked up and retained by the absorbent. This in no way impairs efficiency as a compressor.

This useful stunt is made possible by the fact that slugs of liquid entering a Nash Compressor do no harm to the pump structure. Nash pumps have only one internal moving part, simple, non-wearing, and employ no gas contaminating internal lubrication. There are no valves, gears, pistons, or sliding vanes, and original pump efficiency is maintained over a long life. In a single stage Nash Compressors produce 75 lbs. pressure or vacuums to 26 in. of mercury, with capacities up to 6 million cubic feet per day in a single structure. Investigate these pumps now.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

Original performance constant over a long pump life.

Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

303 WILSON, SO. NORWALK, CONN.

SPECIFIC GRAVITY CORRECTION FACTORS FOR ORIFICE METERS

From	To 0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
0.60	0.8257	0.8211	0.8165	0.8120	0.8076	0.8032	0.7989	0.7947	0.7906	0.7865	0.7825	0.7785	0.7746
0.61	0.8326	0.8279	0.8233	0.8187	0.8143	0.8099	0.8056	0.8013	0.7971	0.7930	0.7889	0.7850	0.7810
0.62	0.8394	0.8346	0.8300	0.8254	0.8209	0.8165	0.8121	0.8079	0.8036	0.7995	0.7954	0.7914	0.7874
0.63	0.8461	0.8414	0.8367	0.8321	0.8275	0.8231	0.8187	0.8143	0.8101	0.8059	0.8018	0.7977	0.7937
0.64	0.8528	0.8480	0.8433	0.8386	0.8341	0.8296	0.8251	0.8208	0.8165	0.8123	0.8081	0.8040	0.8000
0.65	0.8594	0.8546	0.8498	0.8452	0.8405	0.8360	0.8316	0.8272	0.8229	0.8186	0.8144	0.8103	0.8062
0.66	0.8660	0.8611	0.8564	0.8516	0.8470	0.8424	0.8379	0.8335	0.8291	0.8249	0.8206	0.8165	0.8124
0.67	0.8726	0.8676	0.8628	0.8581	0.8534	0.8488	0.8443	0.8398	0.8354	0.8311	0.8268	0.8227	0.8185
0.68	0.8791	0.8741	0.8692	0.8644	0.8597	0.8551	0.8505	0.8460	0.8416	0.8373	0.8330	0.8288	0.8246
0.69	0.8855	0.8805	0.8756	0.8708	0.8660	0.8613	0.8568	0.8523	0.8478	0.8434	0.8391	0.8348	0.8307
0.70	0.8919	0.8869	0.8819	0.8771	0.8723	0.8676	0.8529	0.8584	0.8539	0.8495	0.8452	0.8409	0.8367
0.71	0.8982	0.8932	0.8882	0.8833	0.8785	0.8737	0.8691	0.8645	0.8600	0.8555	0.8512	0.8469	0.8426
0.72	0.9045	0.8994	0.8944	0.8895	0.8847	0.8799	0.8752	0.8706	0.8660	0.8615	0.8571	0.8528	0.8485
0.73	0.9108	0.9057	0.9006	0.8957	0.8908	0.8860	0.8812	0.8766	0.8720	0.8675	0.8631	0.8587	0.8544
0.74	0.9170	0.9118	0.9068	0.9018	0.8968	0.8920	0.8873	0.8826	0.8780	0.8734	0.8690	0.8646	0.8602
0.75	0.9232	0.9180	0.9129	0.9078	0.9029	0.8980	0.8932	0.8885	0.8839	0.8793	0.8748	0.8704	0.8660
0.76	0.9293	0.9241	0.9189	0.9139	0.9089	0.9040	0.8992	0.8944	0.8898	0.8852	0.8806	0.8762	0.8718
0.77	0.9354	0.9301	0.9250	0.9199	0.9149	0.9099	0.9051	0.9003	0.8956	0.8910	0.8864	0.8819	0.8775
0.78	0.9415	0.9362	0.9310	0.9258	0.9208	0.9158	0.9109	0.9061	0.9014	0.8967	0.8921	0.8876	0.8832
0.79	0.9475	0.9421	0.9369	0.9317	0.9267	0.9217	0.9167	0.9119	0.9071	0.9025	0.8978	0.8933	0.8888
0.80	0.9535	0.9481	0.9428	0.9376	0.9325	0.9275	0.9225	0.9177	0.9129	0.9082	0.9035	0.8989	0.8944
0.81	0.9594	0.9540	0.9487	0.9435	0.9383	0.9333	0.9283	0.9234	0.9186	0.9138	0.9091	0.9045	0.9000
0.82	0.9653	0.9599	0.9545	0.9493	0.9441	0.9390	0.9340	0.9291	0.9242	0.9194	0.9147	0.9101	0.9055
0.83	0.9712	0.9657	0.9603	0.9550	0.9498	0.9447	0.9397	0.9347	0.9298	0.9250	0.9203	0.9156	0.9110
0.84	0.9770	0.9715	0.9661	0.9608	0.9553	0.9504	0.9453	0.9403	0.9354	0.9306	0.9258	0.9211	0.9165
0.85	0.9828	0.9773	0.9718	0.9665	0.9612	0.9560	0.9509	0.9459	0.9410	0.9361	0.9313	0.9266	0.9220
0.86	0.9886	0.9830	0.9775	0.9721	0.9668	0.9616	0.9565	0.9515	0.9465	0.9416	0.9368	0.9320	0.9274
0.87	0.9943	0.9887	0.9832	0.9778	0.9724	0.9672	0.9620	0.9570	0.9520	0.9470	0.9422	0.9374	0.9327
0.88	1.0000	0.9944	0.9888	0.9834	0.9780	0.9727	0.9676	0.9624	0.9574	0.9525	0.9476	0.9428	0.9381
0.89	1.0057	1.0000	0.9944	0.9890	0.9836	0.9783	0.9730	0.9679	0.9628	0.9579	0.9530	0.9482	0.9434
0.90	1.0113	1.0056	1.0000	0.9945	0.9891	0.9837	0.9785	0.9733	0.9682	0.9632	0.9583	0.9535	0.9487
0.91	1.0169	1.0112	1.0055	1.0000	0.9945	0.9892	0.9839	0.9787	0.9736	0.9686	0.9636	0.9587	0.9539
0.92	1.0225	1.0167	1.0111	1.0055	1.0000	0.9946	0.9893	0.9841	0.9789	0.9739	0.9689	0.9640	0.9592
0.93	1.0280	1.0222	1.0165	1.0109	1.0054	1.0000	0.9947	0.9894	0.9843	0.9792	0.9742	0.9692	0.9644
0.94	1.0335	1.0277	1.0220	1.0164	1.0108	1.0054	1.0000	0.9947	0.9895	0.9844	0.9794	0.9744	0.9695
0.95	1.0390	1.0332	1.0274	1.0217	1.0162	1.0107	1.0053	1.0000	0.9948	0.9896	0.9846	0.9796	0.9747
0.96	1.0445	1.0386	1.0328	1.0271	1.0215	1.0160	1.0106	1.0053	1.0000	0.9948	0.9897	0.9847	0.9798
0.97	1.0499	1.0440	1.0382	1.0324	1.0268	1.0213	1.0158	1.0105	1.0052	1.0000	0.9949	0.9898	0.9849
0.98	1.0553	1.0493	1.0435	1.0377	1.0321	1.0265	1.0211	1.0157	1.0104	1.0051	1.0000	0.9949	0.9900
0.99	1.0607	1.0547	1.0488	1.0430	1.0373	1.0318	1.0262	1.0208	1.0155	1.0103	1.0051	1.0000	0.9950
1.00	1.0660	1.0600	1.0541	1.0483	1.0426	1.0369	1.0314	1.0260	1.0206	1.0153	1.0102	1.0050	1.0000

FORMULA: $\frac{\sqrt{\text{old gravity}}}{\sqrt{\text{new gravity}}}$ = Multiplier (correction factor)

EXAMPLE OF COMPUTATION: To correct from a gravity of 0.60 to 0.90:

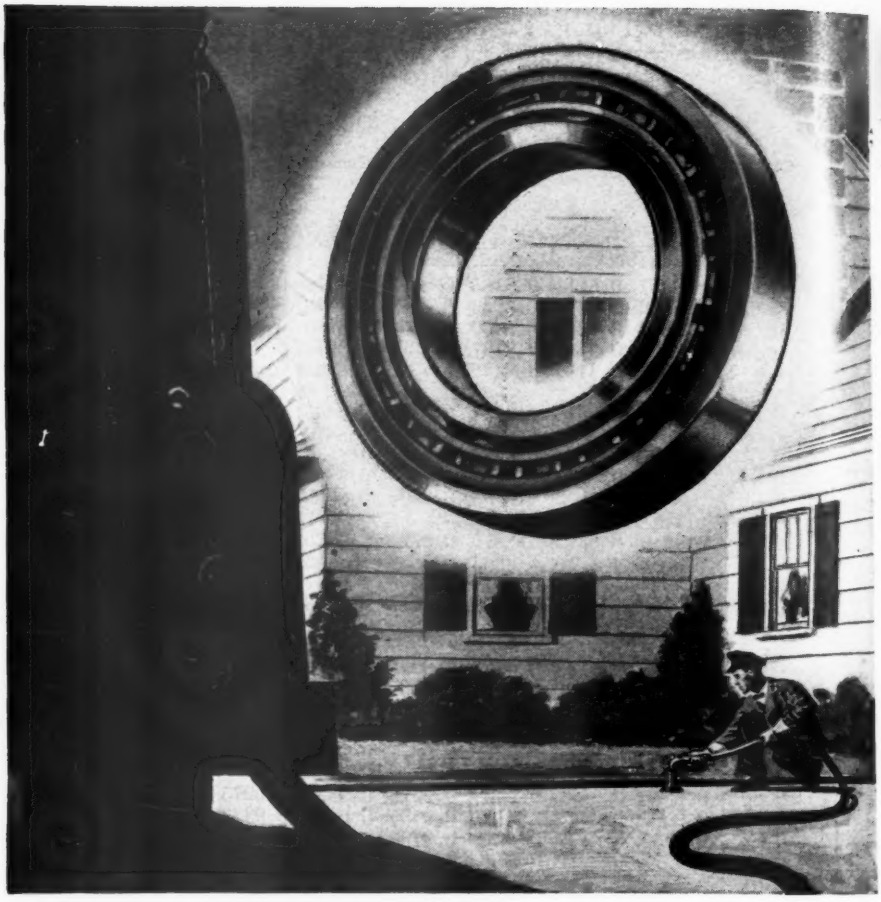
$$\frac{\sqrt{0.600}}{\sqrt{0.700}} = \frac{0.7746}{0.9487} = 0.8165$$ (as shown above on 0.60 line under 0.90)

NOTE: The multipliers in these tables may be used in conjunction with orifice meter coefficients such as *The Petroleum Engineer's* table P 683.320.3, entitled "One Hour Coefficient at Various Pressure Bases," published in June, 1943. Multiplication of any of those coefficients (based on 0.60 gravity gas) by the multiplier in the first line above that corresponds to the actual gravity of the gas being measured through an orifice plate will properly correct the coefficient for use in calculating the actual volume.

EXAMPLE OF USE: The one hour coefficient for a 4 x ¼-in. plate with flange connections in a 4.026 I.D. pipe = 16.6 (for 14.4 lb. plus 4 oz. absolute pressure base, 0.60 gravity, and 60°F. temperature).

Then, for correction from 0.60 to 0.90 gravity, multiply 16.6 by 0.8165 (under 0.90 and on the 0.60 line above) = 13.554 (corrected one hour coefficient).

Rollers Roll



FROM DEEP DRILLING TO HOME DELIVERY!

The petroleum business and Hyatt Roller Bearings have grown up together.

As you know, from everyday experience, drilling and pumping machinery equipped with Hyatt Roller Bearings has had some tough tasks to perform day after day through the years.

And Hyatt's have measured up to the most exacting performance demands.

Wherever oil producing machinery operates, there you will find a preponderance of Hyatt's minimizing friction—keeping wheels, shafts and gears turning day in and out performing steadily with a minimum stoppage for bearing care or replacement. Hyatts see the job through via Hyatt-equipped tank trucks, right to the home owner's door. Hyatt engineers have a wealth of experience in the petroleum field—consultation is invited.

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION

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HYATT ROLLER BEARINGS

Running Tour WITH MEN IN THE INDUSTRY

● Cecil **H. McLain** has announced the opening of his office for practice as a consulting engineer in chemical, petroleum, and corrosion engineering at 528a M&M Building, Houston, Texas. McLain spent 2½ years under Stanley Gill on corrosion, 9½ years with Sinclair in its Houston refinery as a chemical engineer in the technical department, and 2 years and 8 months with J. S. Abercrombie Company. He is a registered professional engineer.

● **R. M. Hurt, E. A. Rose,** and **W. D. Maxwell** of Carter Oil Company have recently been transferred by the company. Hurt, superintendent of the Vicksburg, Mississippi, district and with 18 years' foreign and domestic service with Carter, has been named assistant divisions superintendent of the central division at Seminole, Oklahoma. Rose, superintendent of the Great Bend, Kansas, district, is being transferred to Vicksburg. He has been with Carter for 27 years. Maxwell, superintendent of the Elk Basin, Wyoming, district, and a 20-year employe has been named district superintendent of the Great Bend district.

● **E. I. Boldon** has been appointed assistant manager of the South Bend, Indiana, sales division of Standard Oil Company (Ind.) to replace **A. D. Oetjen,** recently made sales promoter in the company's general offices in Chicago. **R. G. McKinney,** special representative at LaCrosse, Wisconsin, will succeed Boldon as sales manager at LaCrosse.

● **Henry Hauseman,** for 28 years general traffic manager of Pure Oil Company, died October 27 at the age of 64 years. He joined Pure in 1917 and had served continuously with the company in various offices until his death.

● **M. G. Domsitz** returned on November 1 to the Schlumberger Well Surveying Corporation after 3 years spent working on the VT bomb and rocket fuses. He was senior engineer for Schlumberger in the Corpus Christi, Texas, area previous to going with the National Bureau of Standards, Washington, D.C. In the postwar organization of the ordnance department division at NBS, he was chief of a section devoted to pilot production of VT fuses.

M. G. Domsitz

● **K. U. Herbert** has been appointed manager of the refinery sales department of National Refining Company, according to L. S. Peirce, vice president. Herbert has been with National 28 years, formerly serving as assistant to the manager of the refinery sales department. **Earl E. Irons** will be assistant manager of the transportation and supply departments. He joined National in 1933 and was in the refinery sales department 9 years before his transfer to transportation and supply in 1943.

● **W. B. (Bill) Duncan** has been appointed general superintendent in charge of drilling and oil and gas production of the Houston Oil Company of Texas, according to R. P. Hobson, general manager of the company. Duncan joined Houston Oil in March, 1925, and has served in various capacities with the company since that time. His headquarters are in the Petroleum Building, Houston. **C. L. Butchee,** general superintendent of Houston Oil resigned on November 1 after 21 years with the company to go into private business in Beeville, Texas. **Captain R. W. (Bill) Goff,** formerly in the warehouse department of the company, has rejoined Houston Oil as scout in the upper Texas Gulf Coast district following his release from the Army. **R. E. Blewster,** formerly scout in the upper Texas Gulf Coast, has been transferred to the land department in the Houston district.

W. B. Duncan

C. L. Butchee

● **John M. Martin** has been appointed manager of the Pittsburgh, Pennsylvania, explosives office of Hercules Powder Company succeeding **LeRoy Keane** who has been appointed director of sales of the Hercules explosives department in Wilmington, Delaware. Martin was, previous to his appointment, operating manager of the Hercules-operated Sunflower Ordnance Works in Kansas. He joined Hercules in 1934 and has been to South America for the company 3 times. In 1939 he was appointed assistant dynamite line supervisor at the company's explosives plant at Kenvil, New Jersey. In February, 1941, he moved to the Radford Ordnance Works in Virginia to aid in procurement of materials for the first of the government-owned explosives plants of World War II. Six months later

● **Frank Cross,** ex-farm boy who became secretary and treasurer of Sun Oil Company within 6 years after he began work as a $25-a-week bookkeeper, celebrated his 75th birthday on October 24. Cross worked on his father's farm, attended Grove City College and Bryant and Stratton Business College, taught country school and clerked in a bank before he went with Sun Oil in 1893. He became a director of the company in 1901 and 3 years later became treasurer. In the year Cross became treasurer, Sun Oil's gross operating income was $1,143,000 and the net $184,694 (16.1 per cent) compared with a gross of $600,823,000 and a net of $13,350,217 (2.2 per cent) in 1944, attesting the increasing complexity of the work he has handled.

● **G. N. Emmanuel** has joined the metallurgical staff of The Babcock and Wilcox Tube Company in Beaver Falls, Pennsylvania, as research metallurgist. He is a graduate in metallurgy of Massachusetts Institute of Technology. He was formerly associated with the Murray Company, Boston, Massachusetts.

● **Glenn Harsh,** assistant drilling superintendent for Cities Service at Eagle Lake, Texas, has been moved to the North Lindsey field, McClain County, Oklahoma. **Ed Wilder,** farm boss at Phillips County, Kansas, is being moved to the Eagle Lake district to succeed Harsh, according to D. B. Dow, production superintendent.

● **H. T. Hopkins** has been appointed assistant district manager for Republic Supply Company at Kilgore, succeeding Tom C. Hendricks who has been transferred to Wichita Falls as district manager. Hopkins has served Republic at various points throughout the southwest since February, 1923, and has been at Kilgore since February, 1939. In his new position, Hopkins will continue to make his headquarters at Kilgore but will serve as assistant to J. B. Lionberger, district manager at Shreveport, Louisiana, and will cover the territory included in that district west of the Mississippi River.

H .T. Hopkins

● **J. T. L. McNew,** vice president for engineering of Texas A&M College, has been elected official nominee for vice president of Zone 4 of the American Society of Civil Engineers. Nomination is tantamount to election. The zone includes southern Mississippi, Louisiana, Texas, New Mexico, Arizona, California, Nevada, Utah, Idaho, Oregon, Washington, and western Montana. The vice presidency is for a period of 2 years beginning January 1, 1946. This is the third office McNew has held in the American Society of Civil Engineers. He has previously served as secretary-treasurer in 1927-28 and a member of the board of directors, 1941-44. This is the first time a civil engineering employe of Texas A&M College has been nominated for vice president. McNew served in both world wars in the corps of engineers. He

ORBIT VALVES

ORBIT

UNEQUAL FLANGED

MASTER VALVES

... Make your Christmas Tree more compact. Eliminates the use of an adapter flange and the chances for additional gasket leaks. The flanges are integral with the body of the valve. These valves incorporate all the advantages of the FRICTION FREE—trouble free Orbit principle.

Orbit Gear Operated Master Valve

AVAILABLE AT YOUR FAVORITE SUPPLY STORE OR CHRISTMAS TREE FABRICATOR AT PRICES COMPARABLE TO THOSE OF COMPETITIVE VALVES.

See Pages 2194 to 2211 in 1944 Composite Catalog

Orbit Valves Require No Lubrication to Effect a Seal.

ORBIT VALVE COMPANY

TULSA, OKLAHOMA

was released recently with the rank of lieutenant colonel after service in the China-Burma-India theater of operations.

● **W. W. Anderson** of Oil City, Pennsylvania, veteran export employe of Oil Well Supply Company, U. S. Steel Corporation, has retired after 44 years with the company. He entered the employ of the company in 1901 in the stockroom at Pittsburgh, Pennsylvania. In 1907 he was made export manager, in 1923 assistant secretary, and in 1925 secretary of the company. In 1930 he moved to Oil City and took charge of export sales at the Imperial Works of Oil Well Supply Company. He remained at his work throughout the critical war period.

● **Brigadier General Walter B. Pyron,** vice president of the Gulf Oil Corporation, has returned to active duty with the company after being discharged from the Army. He will maintain offices for the company in London where he will be in charge of all producing operations in Europe and in the Near East. He served as coordinator of fuel and gas supplies to the Army and Navy.

● **E. O. Jones** after 2 years with PAW has rejoined Ethyl Corporation and will be a staff assistant to Julian J. Frey, general sales manager. Jones had been with Ethyl 12 years and was serving as acting assistant manager of the safety department when he joined PAW in October, 1943, as a petroleum engineer. He was later appointed special assistant to A. P. Frame, director of refining of PAW.

● **Archibald S. Sutherland,** 45, assistant general traffic manager of Sun Oil Company, died October 24 after being struck by an automobile while crossing a street near his home in Philadelphia. Sutherland joined Sun as a clerk in the traffic department in 1919 and became assistant general traffic manager in 1943. He served as acting general traffic manager during the recent absence of Porter L. Howard, on leave from Sun with ODT.

● **Carleton D. Speed, Jr.,** moved from Houston August 1 to Sinton, Texas, where he became superintendent of exploration and chief geologist for Plymouth Oil Company. Speed moved to Houston 9 years ago where he organized the Speed Oil Company. In 1941 he purchased all the assets of the company and has continued to operate as an independent geologist and oil producer in Texas and Illinois. He is past president of the Houston Geological Society and has held every elective office within the Houston society. During World War II Speed served for 2 years with PAW, returning to Houston in 1944.

● **Porter L. Howard** has returned from government service to his job as general traffic manager of the Sun Oil Company but remains on call to advise Colonel J. Monroe Johnson, director of ODT on special problems. It is the third time Howard has left and then returned again to ODT. Active in the transportation and petroleum industries since 1904, Howard was described by Colonel Johnson as "one of the few transportation men in the oil industry who has had practical experience with all of the forms of petroleum transportation—movements by pipe line, rail, truck, and water."

● **D. H. "Friday" Hyler** has joined the sales staff of the Republic Supply Company with headquarters at the general offices of the company in Houston. His work will be in connection with refinery and industrial sales. Prior to joining Republic, Hyler spent 30 years in active refinery operations. For the last 21 years he has been connected with the Continental Oil Company and for 19 years has been in charge of that company's Wichita Falls refinery.

D. H. Hyler

● **Chester A. Snell** has joined the staff of Foster D. Snell, Inc., consulting chemists and engineers, 305 Washington Street, Brooklyn 1, New York. Dr. Snell has for the last 3 years been connected with the chemical development division, Aluminum Company of America. He is a graduate of Polytechnic Institute of Brooklyn where he received his B.S., M.S., and Ph.D. degrees in chemistry.

● **E. L. Stacy,** who just returned from the wars a captain, will rejoin Lane-Wells Company as radioactivity operator. Stacy was particularly irked at the Germans while doing geophysical work in Germany prior to the Nazi push into the low countries. Just as regularly as his ROTC extension course arrived, so regularly would the Nazis throw Stacy in jail where he would have to do a lot of tall talking to get out. He had no sooner gotten out of the country when Uncle Sam declared war, thereupon Stacy volunteered to go back and get even.

● **E. G. Dahlgren,** assistant secretary of the Interstate Oil Compact Commission, Oklahoma City, attended the two-day session in Washington, D. C., of the Conference of Petroleum Regulatory Authorities, which organization is expected to write itself off the books soon, now that the cessation of hostilities no longer necessitates its existence.

● **Colonel William C. Kinsolving** has been appointed manager of all Sun Oil Company pipe line operations, J. Edgar Pew, vice president, has announced. Col. Kinsolving, formerly manager of the Sun Pipe Line Company, Texas, was recently released by the Army where he had charge of building the section of the India-Burma-China pipe line that runs from Calcutta up the Brahmaputra Valley and into Assam on the India-Burma border. He was on leave from Sun as assistant director of transportation for PAW at the time he entered the Army. He played a prominent part in planning

the Big Inch line in 1943, and in the construction of the Sun-Susquehanna system in 1930-31. He will maintain headquarters in Philadelphia.

● **John E. "Gene" Compton,** a former captain in the AAF, has returned to Lane-Wells Company as superintendent of the Healdton, Oklahoma, station.

● **R. B. "Ike" Downing** has put away his uniform of a major in the AAF intelligence section and is now superintendent of the Oklahoma City district of Lane-Wells Company.

● **J. Gerald Godsoe,** chairman of the Wartime Industries Control Board and coordinator of controls in the department of munitions and supply, has accepted a position with British American Oil Company as executive vice president succeeding **Dr. F. A. Gaby** who is retiring. Godsoe will continue in his other two positions for some time. In his present position at Ottawa, Godsoe has been one of the key figures responsible for the supply and distribution of the basic war materials and transportation services for the whole of Canada's war industry. Dr. Gaby's retirement concludes nearly half a century devoted to the industrial development and progress of Canada. He held numerous executive positions in various fields of industry before going with British American in 1936.

● **Mary Sue Collins,** treasurer of the Western Petroleum Refiner's Association, Oklahoma City, Oklahoma, is leaving that organization and will be succeeded by **Lucille Dennis.**

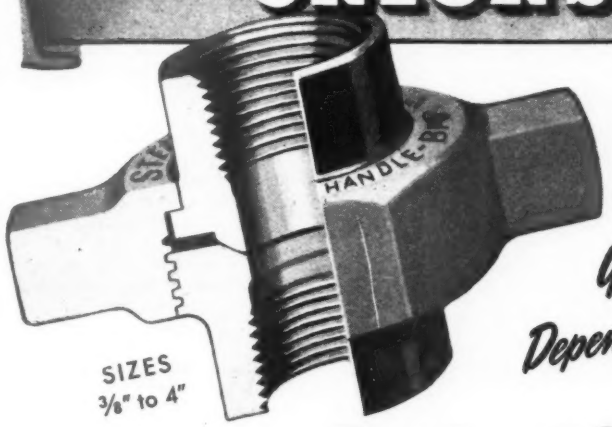
● **John C. Day,** secretary of Western Petroleum Refiner's Association, Oklahoma City, Oklahoma, is making plans to revive the technical meetings of that organization, which were discontinued during the war. It is planned to have the initial meeting after the first of the year.

● **J. T. Hayward,** who has been on loan to the U. S. Naval mine warfare test station at Solomons, Maryland, where he was chief scientist, has returned to Tulsa, Oklahoma, and taken up his duties as vice president of the Barnsdall Research Corporation.

● **William R. "Jack" Mays,** formerly at Duncan, Oklahoma, in the Resin Seal Service Department of the Halliburton Oil Well Cementing Company, has been transferred to the Kilgore district laboratory.

● **Rupert F. Carroll** has been promoted to district civil engineer, Willamar District, Raymondville, Texas, of the production department, Humble Oil and Refining Company. Other changes are **James E. Ozburn** promoted to district civil engineer, London District, Overton, Texas; and **Verne E. Wesley** promoted to district civil engineer, Scott and Hopper District, Encino, Texas. **Jamie M. Spiller,** civil engineer returning from military leave, was transferred from the North Crowley district, Crowley, Louisiana, to the East Texas division office, Tyler, Texas, as district civil engineer.

FORGED STEEL UNIONS



Your Most Dependable Servants

Handle-Bar UNION

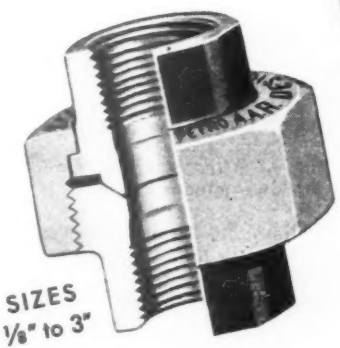
4000 AND 6000 TEST

4000 Test: Sizes 3/8" to 1½" V-thread in nut. 4000 and 6000 Test: Sizes 2" to 4" modified Acme Threads in nut. Steel to steel, or bronze to bronze cold rolled seats. Permanently lubricated nut threads. To tighten, or loosen the nut, USE A HAMMER INSTEAD OF A WRENCH. *Write for pamphlet 4P-HB.*

SIZES
2", 2½", 3"

Petro UNION CHECK VALVE

A Check Valve that checks without shock or noise. The spring controls the opening and closing of the valve in accordance with the volume and velocity of the flow. Can be used in any position—vertical, horizontal, or upside down. Furnished as shown, or with Handle-Bar Nut. Navy bronze, or 18-8 stainless steel seats. *Write for pamphlet 4P-HB.*



SIZES
1/8" to 3"

Petro UNION

Exclusive Features that pay dividends to the User. Extra Heavy ends and Nut. Permanently lubricated nut threads. Machined and cold rolled seats. Pressures from a vacuum to 3000 lbs. Temperatures from 100° below Zero F to 1000° above Zero F. Steam, Gas, Air, Ammonia, Oil, Gasoline, Chemicals, and all services in which steel, or wrought iron pipe is used. Made to A.A.R. standards and priced in line with 300-lb. A.A.R. Malleable Iron Unions. *Write for Pamphlet AM-67.*

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1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Say "DOUBLE E" WHEN YOU WANT .... The Best

TUBING CATCHER

The outstanding advantage of the DOUBLE E Multiple Step Tubing Catcher is that it protects the tubing without distorting the casing. This is accomplished by the multiple step design, which permits an extra large gripping surface, distributing the load over a much greater area than other catchers. Note the illustration at left. The simplicity of design and the heavily sectioned parts of this tubing catcher naturally are points of importance in providing long and economical life.

Tubing Catchers can be supplied with or without anchors. The anchors can be furnished for left-set or right-set, as desired.

"DOUBLE E" Products

EQUIPMENT ENGINEERS

INCORPORATED

2039 AMELIA STREET

DALLAS 9, TEXAS

LAUGH WITH BARNEY

Grandma (looking at granddaughter's bathing suit): If I could have had clothes like that when I was a girl, you'd be six years older today.

* * *

"Now Son," said the father, "tell me what I punished you for."

"That's fine," blubbered the kid, "first you pound hell out of me and now you ask why you did it."

* * *

Salesman: I've been trying for two weeks to see you. When may I have an appointment?

Manager: Make a date with my secretary.

Salesman: I did, sir, and we had a grand time, but I still want to see you.

* * *

Landlady (in hall, talking to a gal): I thought I saw you taking a gentleman up to your apartment last night, Miss Brown.

Miss Brown: Yeah; that's what I thought.

* * *

A stenographer defines a wolf as a modern dry cleaner. He works fast and leaves no ring.

* * *

Back from the war zone is the story of the Scotch Commando who spent six months in occupied France, looking for a Free French Woman.

* * *

A low-brow is a person who likes peppy stories, girlie shows, and good times; a high-brow is a low-brow who won't admit it.

* * *

A young mother came to the door of the nursery and saw her husband standing over the baby's crib. Silently she watched him as he stood looking down at the sleeping infant. In his face she read rapture, doubt, admiration, ecstasy, incredulity, wonder. Deeply touched, with her eyes glistening, she tiptoed near, slipped her arms around him.

"A penny for your thoughts," she said tenderly.

Startled into consciousness, he blurted, "For the life of me I don't see how anybody can make a crib like that for $3.49!"

* * *

The young man who had been calling so frequently on Helen came at last to see her father. Finally, the suitor made this announcement: "It's a mere formality, I know, but we thought it would be pleasing to you if it were observed in the usual way."

Helen's father stiffened.

"And may I inquire," he asked, "who suggested that asking my consent to Helen's marriage was a mere formality?"

"Yes," replied the young man. "It was Helen's mother."

* * *

"Let me off at the next stop, conductor. I thought this was a lunch wagon."

* * *

Mama Mosquito: If you children are good, I'll take you to the nudist camp tonight.

* * *

Bashful Boy: Sir, Jane and I have decided that our happiness is the biggest thing in the world.

Father: You change your minds so often—just yesterday you wanted to marry her.

* * *

"Why do you want a new trial?"

"On the grounds of newly discovered evidence, your honor."

"What was the nature of it?"

"My client has dug up $400 I didn't know he had."

Just think of some poor captain
Minus all his silver bars,
Standing up behind some counter
Selling peanuts and cigars.

Think of all the majors
With their oak leaves far behind
And the uniforms they're wearing
Are the Western Union kind.

Shed a tear for some poor colonel,
If he doesn't feel himself;
Jerking sodas isn't easy,
When your eagle's on the shelf.

'Tis a bitter pill to swallow,
'Tis a matter for despair,
Being messengers and clerks again,
A mighty cross to bear.

So be kind to working people
That you meet where'er you go;
For the guy who's washing dishes
May have been your old CO.

* * *

"I didn't accept Bob the first time he proposed."

"No, you weren't there."

* * *

"I never kiss a girl except on great occasions."

"What do you call great occasions?"

"Whenever I kiss a girl!"

* * *

"Heavens, Ter Veer, what has happened to you?" asked the lawyer's friend as he viewed him in astonishment. "Been in an auto accident or something?"

Wearily the lawyer shook his head and gingerly touched his bruised and bandaged face.

"No. Remember that fellow I defended in court last Saturday? I made a strong plea on the ground that he was an irresponsible idiot rather than a criminal. They acquitted him—"

"Yes—?" asked the friend.

"And he waited for me outside the court."

* * *

The young mother asked the man who supplied her with milk if he kept any calves, and smiled pleasedly when he said that he did.

"Then," she continued brightly, "bring me a pint of calf's milk every day. I think cow's milk is too strong for baby."

* * *

Visitor at a Texas Ranch: Has the radio helped ranch life much?

Cactus Joe: It shore has. We learn a new cowboy song every night. Besides, we have found out the dialect that we have been using for years is all wrong.

* * *

"Now, let me see," the impecunious man demanded as he buttonholed an acquaintance, "do I owe you anything?"

"Not a penny, my dear sir," was the genial reply. "You are going about paying your little debts?"

"No, I'm going about to see if I've overlooked anybody. Lend me ten till Saturday."

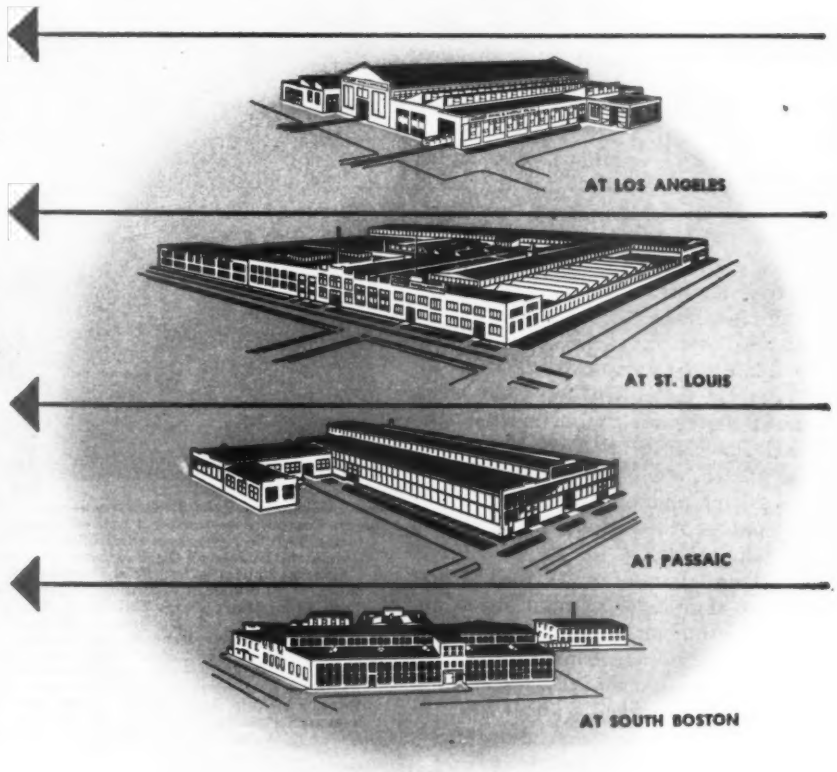
* * *

An acquaintance was reproaching a Scotch-American with accusations of poor sportsmanship. "You never take a chance," he said disgustedly. "Why, you wouldn't bet that the sun would rise tomorrow morning."

Instantly Sandy replied: "What odds will you give me?"

TO THE USER OF FABRICATED PIPING

4 PLANTS Are Better THAN 1



There are four Midwest pipe fabricating plants located in different parts of the country, because Midwest has found that "four plants are better than one" for the user of piping.

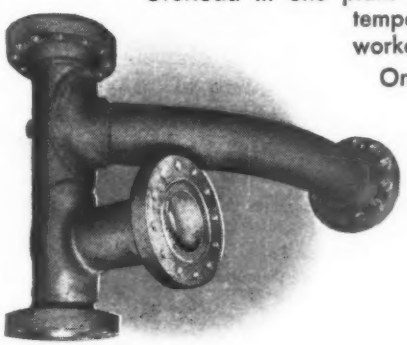
In addition to shortening shipping distances and making for a better understanding of the customers' individual problems, four plants provide other important benefits in which all Midwest Piping users participate.

Extra reserve capacity is provided for the emergency job. If extreme speed is sufficiently important, a job can be divided among two or more plants. An overload in one plant often can be handled by temporarily transferring skilled workers from other plants.

One of the greatest advantages is the continuous exchange of information and experience between staff members of the four plants. New techniques developed in one plant are made known to all. Piping problems which may be new to one plant probably are very familiar to another where the "know how" information is available at once. Friendly rivalry—constant study of piping problems by four organizations—tends to advance the art of piping fabrication much more rapidly than would otherwise occur.

All of this works to the advantage of piping users —four plants are better than one.

Midwest can give you better piping and better service . . . whether you need only a simple bend or the most elaborate piping job completely erected and ready for operation.



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MIDWEST **PIPING AND SUPPLY COMPANY, Inc.**

Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic (N. J.) and Los Angeles
Subsidiary: Lumsden & Van Stone Co., South Boston 27, Mass.
Sales Offices: New York 7—30 Church St. Chicago 3—645 Marquette Bldg.
Los Angeles 33—520 Anderson St. Houston 2—229 Shell Bldg.
Tulsa 3—533 Mayo Bldg. Atlanta 3—Red Rock Bldg. South Boston 27—426 First St.

PIPING FABRICATORS AND CONTRACTORS

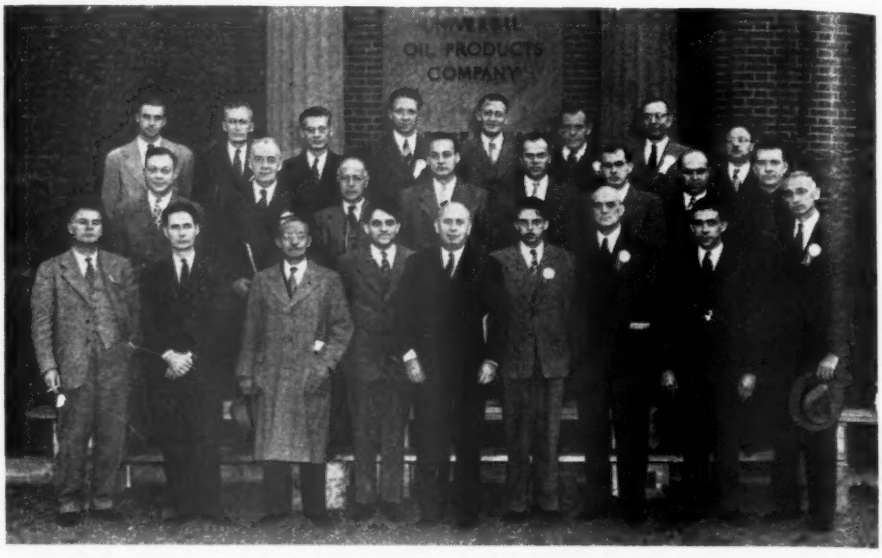
Mexican-American research conference

Invention and development by Universal Oil Products Company of a catalytic cracking unit of radically new design was announced recently by Dr. Gustav Egloff of Universal at a luncheon meeting of the Mexican-American Conference on Industrial Research, which was sponsored by the Illinois Institute of Technology.

This new UOP cat cracker can be installed at low cost and fitted to small-scale refining operations, Dr. Egloff said. It makes practical for the small refiner the use of the most modern procedures and technique of catalytic cracking to produce superior quality aviation and motor gasoline. It puts within his reach the same advantages that the large companies long have enjoyed in catalytic cracking, he said.

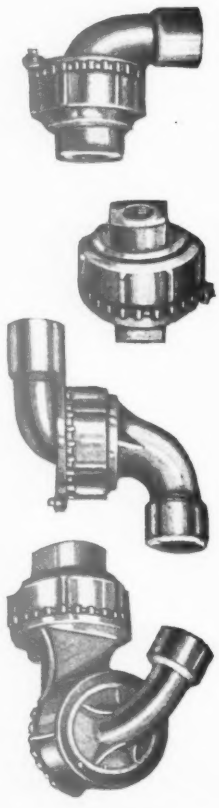
After Dr. Egloff's address, the members of the conference visited the Universal laboratories at Riverside, a Chicago suburb, where they were conducted on a 2-hour tour of inspection through all departments, observing hydrocarbon research in action.

In those laboratories the world's first program of research in catalysis, as applied to petroleum refining, was initiated more than a decade before Pearl Harbor, with foresight that today seems uncanny if not providential, because from that research work stemmed the processes that provided 100-octane gasoline, high quality military motor gasoline, components of synthetic rubber and toluene for the production of TNT.



Members of the Mexican-American Conference on Industrial Research, with Universal Oil Products Company men, after a tour of inspection through the company's research and development laboratories. Left to right, first row: Maurice Holland, industrial research adviser, New York City; Dr. J. D. Danforth, Universal Oil Products Company; Dr. Gustav Egloff, Universal; C. G. Gerhold, manager, Universal Laboratories; Paul Truesdell, Universal; Dr. Francis W. Godwin, associate director Armour Research Foundation of Illinois Institute of Technology; George H. Houston, Houston and Jolles, New York City; Davis Read, Universal; Dr. Linton E. Grinter, vice president, Illinois Institute of Technology. Second row: Dr. Jesse E. Hobson, chairman of the conference and director, Armour Research Foundation; James Drumm, vice president, National City Bank, New York City; L. A. Mekler, Illinois Institute; Norman C. Penfold, Armour Research Foundation; Jack Louthan, Armour Research Foundation; Donald Gray, Armour Research Foundation; Joseph Lepic, Armour Research Foundation; Reginald A. Shewry, Armour Research Foundation. Top row: W. E. Lemen, Universal; William G. MacLean, State Department, Washington, D. C.; E. R. Kanhofer, Universal; Dr. H. A. Leedy, Armour Research Foundation; Dr. H. H. Wenzke, Universal; C. L. Williams, Armour Research Foundation; Harry L. Wells, Illinois Institute of Technology; Dr. Louis Kassel, Universal.

FLEXO JOINTS



—are dependable

It makes no difference how hard the service may be—with high or low pressure steam, compressed air, oil, hot or cold water—you can always depend on FLEXO JOINTS.

Any desired pipe line flexibility can be obtained by using a combination of the 4 styles of FLEXO JOINTS (illustrated at left). They will swivel through 360° yet there is no restriction of the flow of fluid through the fitting. There is a full pipe area in all positions.

Made of bronze for hard usage and lots of it—the life of FLEXO JOINTS is indefinite and they are as simple as they are efficient; no springs or small parts to lose or ground surfaces to wear. All moving parts are entirely enclosed and fully protected from dirt and grit.

FLEXO JOINTS are easily installed, maintain the alignment of piping and will outlast the pipe or machine to which attached.

Standard pipe sizes from
¼ inch to 3 inches.

Write for details on their use in your service.

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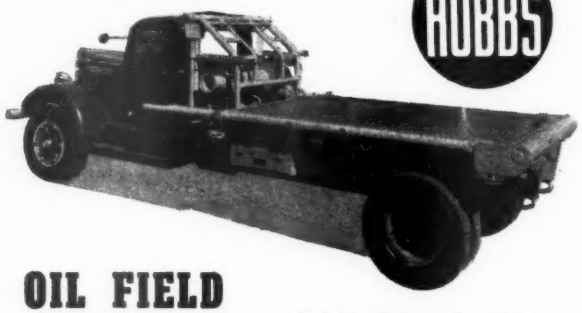
4230 Olive Street St. Louis (8), Mo.

In Canada:
S. A. ARMSTRONG, Ltd.
115 Dupont Street Toronto (5), Ontario

"UTILITY MAN" OF THE OIL FIELDS

HOBBS



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Here's the body that's built to out-last your trucks. Looks good with any chassis or cab. Available either for mounting in our factory or can be shipped out either domestically or for export. Easy to mount. We also handle accessories, boomers, snatch blocks, etc., for complete assembly in one place.

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YOU CAN REAM YOUR PIPE

More quickly and Easily

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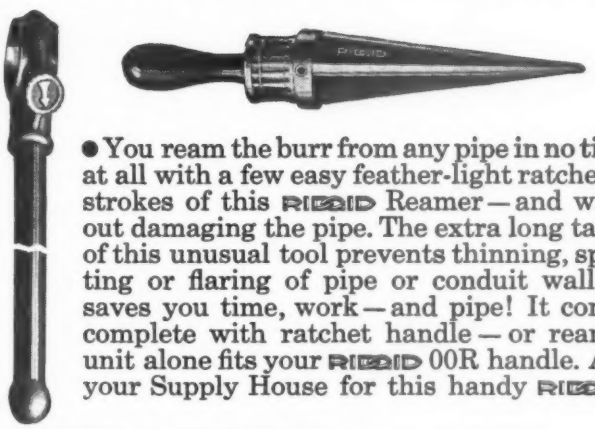
RIDGID REAMER

It won't thin, flare or split pipe



● You ream the burr from any pipe in no time at all with a few easy feather-light ratcheted strokes of this RIDGID Reamer—and without damaging the pipe. The extra long taper of this unusual tool prevents thinning, splitting or flaring of pipe or conduit wall. It saves you time, work—and pipe! It comes complete with ratchet handle—or reamer unit alone fits your RIDGID 00R handle. Ask your Supply House for this handy RIDGID.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

ELECTRICITY

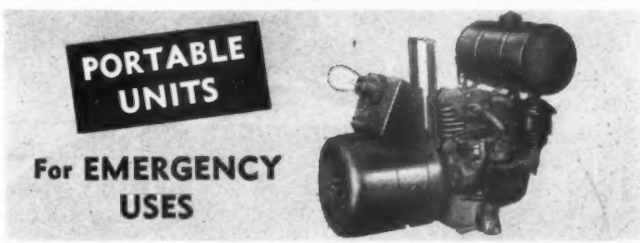
WHERE You Want It
WHEN You Want It

Model Shown: 6.25 KVA. 4-cylinder, gasoline. Water cooled. Push-button starter.

U. S. Electric Plants are engineered by men familiar with oil-field operating problems . . . and backed by over 50 years of manufacturing experience. Operating panel and instruments under weather-proof housing. Compact. Skids make handling easy. Complete line includes Gasoline units from 500 watts to 75 KW; Diesel units from 2 to 75 KW. AC and DC.

Model Shown: 1500 watts, 115 volts, AC. Automatic control. Single cylinder, air-cooled engine.

U. S. Automatic Electric Plants start when the first light is turned on . . . stop when the last light is turned off. Manual control units also available. Can be supplied for operation on natural gas. Simple, trouble-free design and rugged construction have made these units famous for reliability. 800 and 1500 watt models are the most popular for camp lighting.



Unit Shown: 600 watts, DC.

Wherever a breakdown occurs, get things going again in a hurry . . . no need to work in the dark if this compact 67-pound electric plant is kept handy! Other Portable units up to 15 KW. Write for literature.

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U. S. Electric Plants, 7001 S. San Pedro St., Los Angeles 3, Calif.
Southwest Equipment Co., 705 Ross Ave., Dallas and Kilgore, Texas.
C. A. McDade Co., 6526 Hamilton Ave., Pittsburgh 6, Penn.
Midland Implement Co., Box 2113, Billings, Mont. and Great Falls.

U.S. ELECTRIC PLANTS
GASOLINE • DIESEL

L. A. NOMADS INITIATE

LOS ANGELES NOMADS gathered in the Mayfair Hotel October 10, to find out what Hi Cassidy had cooked up in the way of education and entertainment for the regular monthly session. And Hi kicked through in his always capable manner with a nicely balanced program that was worthy of a much larger audience.

There is never lacking an interesting roster of foreign visitors to add the atmosphere of internationalism to these parties. Among those present on this occasion were R. Godfrey, Bahrein Petroleum Company; C. E. Goss, Compania de Petroleo Shell de Colombia, formerly with Caribbean Petroleum Company, Venezuela; C. F. "Jerry" Rideaux, formerly of United Geophysical Company, Chile; Norman Rogers, Ecuador Oilfields, Ltd.; H. H. Shephard, Anglo-Ecuadorian Oilfields, Ltd., and James Nelson of Barba, Costa Rica, who will soon return to Costa Rica to represent Vapor Recovery Systems Company. Also present, from Tulsa, Oklahoma, was R. P. "Salty" Clark of Lucey Products Corporation.

Frank Long of Vapor Recovery Systems; James Nelson, Costa Rica.

Ray Humphreys, Axelson; Lou Bronzan, Baash-Ross; Harry Shephard, Anglo-Ecuadorian Oilfields; Norman Rogers, Ecuador Oilfields.

C. F. Rideaux, formerly United Geophysical, Chile; John Flanagan and W. Betis, M. O. Johnston Oil Field Service.

J. P. Ensh, Shell; R. Godfrey, Bahrein Petroleum; H. Pullman, Baker Oil Tools; C. E. Goss, Shell de Colombia; Earle Boggess, Baker Tools.

Opening the festivities for the evening was an initiation involving two personable lads—Frank Long and Don Grable. Introduced by Billy McGraw, the prospective members were led to the induction center by Custer Morrow and there left to the tender mercies, if any, of Ted Forsyth, chairman of the membership committee. Ted had obviously looked inquiringly into their respective pasts and had emerged with some juicy morsels of scandal, which he proceeded to lay before the house. In spite of the attempt to smear their family escutcheons, however, the gentlemen were duly received into membership.

The chairman introduced L. S. Peterman, oil industry contact engineer for the Southern California Edison Company, who pointed out some of the intriguing channels into which electric power is helping to carry peacetime industry.

The grand windup of the evening was a showing of the motion picture, "Unfinished Horizons," the story of the Aluminum Company of America.

The only sad note in an otherwise hilarious evening was when Owen Lake became the unwitting victim of a suspicious waiter. Owen ate his shrimp cocktail and then went out to comb his hair. When he returned the waiter couldn't remember having taken his ticket, in fact, couldn't remember ever having seen him before. For a time it looked as if Owen had had all the dinner he was going to get, which was bad because he was very hungry. However, the other guests at his table not only prevailed on the waiter to bring in an extra steak, but even helped to eat it, so everything turned out all right. But from now on Owen is gonna call for witnesses when he hands his ticket to the waiter

★ ★ ★

Regional manager

Cummins Engine Company, Inc., Columbus, Indiana, manufacturers of diesel engines for automotive, industrial and marine applications, has announced the appointment of James G. Hull as manager of the Fort Worth region. Offices for the region, which includes all of the Mid-Continent area, are at 1812 Fair Building, Fort Worth 2, Texas.

James G. Hull

Hull, for the last year a sales engineer at the home office in charge of all oil field accounts, succeeds Jay B. Chambers, who resigned recently to purchase the Denver dealer franchise for Cummins engines.

Hull for 6 years has been affiliated with Cummins in various capacities, from shop to engineering, and is thoroughly familiar will all types of diesel engine applications. As a result of his work as oil field sales engineer, he is widely acquainted with operators and equipment manufacturers in the Southwest.

A native of Indianapolis, he was graduated from Purdue University with an M. E. degree, is married and has one child. He expects to move his family to Fort Worth soon.

Princeton trustee

Election of Harry C. Wiess, '09, president of the Humble Oil and Refining Company of Houston, Texas, as a charter trustee of Princeton University and the induction as an alumni trustee of Comdr. David H. McAlpin III '20, in civilian life a member of Clark Dodge and Company, New York financial firm, were announced by Dr. Harold W. Dodds, president of the university.

Wiess, who has been in the Texas oil business since his graduation from Princeton, was one of the organizers of the Humble Oil and Refining Company in 1917 and has been president since 1937. As a charter trustee of the University he will be a permanent member of the board.

Statement of Ownership, Management, etc., of THE PETROLEUM ENGINEER
September 27, 1945
(This statement is published in compliance with the Act of August 24, 1912.)
Published at Dallas, Texas, monthly August through June, semi-monthly in July.
Publisher: The Petroleum Engineer Publishing Co., Dallas, Texas.
Editor: K. C. Sclater, Dallas, Texas.
Managing Editor: F. H. Love, Dallas, Texas.
Business Manager: W. T. Bryan.
Stockholders holding 1 per cent or more of total amount of stock: A partnership composed of W. T. Bryan, J. T. Crowley, W. L. Love and K. C. Sclater, all of Dallas, Texas, doing business under the name of The Petroleum Engineer Publishing Company.
Known bondholders, mortgagees and other security holders holding 1 per cent or more of the total amount of bonds, mortgages or other securities: None.
W. T. Bryan, Partner.
Sworn to and subscribed before me this 27th day of September, 1945.
Edwina H. Cameron, Notary Public.
(My commission expires June, 1947.)

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LUNKENHEIMER VALVES

cost us LESS per Year of Service!

In buying a valve, as in buying anything else, it's *value* you're really after.

What is the measure of valve value? Length of service life, efficiency of performance, time and expense required for maintenance . . . these are the principal factors.

In these and in all other elements of value, Lunkenheimer Valves have proved their superior worth throughout American industry, in wartime as in peacetime. Maintenance men everywhere rely implicitly on these *better valves* because they know they are *better values—quality-built* in every detail, assuring longer and more efficient service with the very minimum of maintenance trouble and expense.

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BRONZE, IRON, STEEL, AND CORROSION RESISTANT ALLOY VALVES—
AIR DEVICES, LUBRICATORS, AIRCRAFT FITTINGS

WANTED: CHIEF ENGINEER

Executive with ability to take full charge of all engineering, research, and development. Must be familiar with oil refinery equipment and construction, general steel plate construction, and general process equipment. Location, midwest. Write giving full information, age, education, experience, salary, references, etc. Box 36, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

WANTED: MINING or PETROLEUM ENGINEER by Major Oil Company. Recent graduate or with some experience, for Exploration and Production Engineering work. Training course if inexperienced. Write Box 32, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

WANTED: MECHANICAL ENGINEER

Major Oil Company requires graduate Mechanical Engineer for Production Department. Either experienced or inexperienced. Write Box 33, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

GEOLOGIST-SUBSURFACE

For Venezuela, five years' experience, preferably foreign.

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SALESMEN WANTED

Leading oil field Production Equipment Manufacturer requires men for sales force, engineering experience and education desirable. Present complete personal data and photograph with application. Our employees have been advised of this advertisement. Address Box 37, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

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To watch progress of wells in Eastern Venezuela. Care for samples, picks, casing points, core points, etc. Write

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WANTED

Oil field equipment manufacturer of international prominence desires to employ two Mechanical Engineers or Designing Draftsmen, with approximately 5 years experience in the design of heavy oil field drilling equipment. Address replies: IDECO, Box 3350, Beaumont, Texas.

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● When steel pipe is coated with Reilly Enamel, corrosion is stopped before it has an opportunity to start. This hard, tough coating seals the steel against the corrosive agencies that seek to destroy it, thoroughly insulates the pipe against extraneous materials and elements, and effectively resists soil stress and abrasion.

Reilly Enamel is so regulated in its properties that it will withstand temperatures as low as minus 20° F. without cracking or chipping, and as high as 160° F. without flow or sag. As a result, pipe lines coated with Reilly Enamel are exceptionally free from costly service interruptions, and render years of service at low maintenance costs.

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FIELD GEOLOGIST

Exploration work in Venezuela. Should have 3 years experience in mapping Rocky Mountains, California or Foreign. Write to

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Large Oil Company requires services of experienced man in home office in East. Salary to fit the man. Write full particulars, education, experience, references. Reply to B-53, P. O. Box 3495, Philadelphia 22, Pennsylvania.

WANTED: GEOLOGIST by Large Major Oil Company. Minimum requirements B.S. or B.A. degree, geology major. Previous experiences not required. Write Box 34, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

GEOPHYSICIST

To act as field supervisor of contract parties. Eastern Venezuela. Write to . . .

THE ATLANTIC REFINING CO.
(Rm. 900) P. O. Box 7258
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Advertising manager

The appointment of Robert M. Darr to the position of advertising manager of Le Roi Company and Centaur Company has been announced by John Dolan, manager of the sales division.

R. M. Darr

Darr joined Le Roi Company in January, 1941, as an instruction manual copywriter and became manager of that department a few months later. Because his work involved extensive research and planning in the publishing of U. S. Army and Navy technical manuals and service parts catalogs, he is completely familiar with the design and maintenance procedure of the entire line of Le Roi products.

Darr brings to the advertising department a wealth of experience. He attended the John Huntington Polytechnic Institute, studying commercial art and reproduction, and later continued his studies of advertising and merchandising at Marquette University. He spent four years with a large tractor manufacturer as a copywriter and layout man for instruction manuals, and gained additional sales and service experience with the L. D. Mather Company.

ISAP to meet

Officials of the South American Petroleum Institute are actively continuing preparatory work for the first convention of that organization, to be held in Lima, Peru, in January, 1947.

Numerous problems of the South American petroleum industry will be considered at this meeting. One subject of principal importance will be the study of means of increasing oil production in South America. Measures that should be taken to obtain maximum economy in the production and utilization of oil will be recommended. Delegates at the convention will also consider the petroliferous possibilities of the country with the object of determining the areas having the most favorable outlook.

Refining matters will be given due consideration as well. Processes used in South American refineries will be discussed and steps taken to make any improvements considered needed.

Transportation facilities now in existence and means of increasing their capacity will be another matter before the meeting.

Final details of the convention's program and procedure will be made at a meeting of the International Permanent Council of the Institute at a meeting in Santiago de Chile in January, 1946.

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for Oil—Gas—Gasoline—Sewer and Water Lines—Drainage —Telephone and Telegraph Conduit—Building Foundations

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CLEVELANDS Save More . . . Because They Do More

Let's TALK TURKEY ★ YOU CAN

Eliminate and Prevent Boiler Scale and Corrosion

SAFELY AND AUTOMATICALLY

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"The Entirely Different Boiler and Engine Treatment"

Make every day a "Thanksgiving Day" for increased operating efficiency and reduced fuel costs.

The action is entirely automatic, and absolutely safe to personnel and equipment—comes ready to use.

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Director of quality

Harry G. Howell, vice president in charge of production of Tube Turns, Inc., Louisville, Kentucky, has announced the appointment of Fred C. Smith as director of quality.

F. C. Smith

A native of Marion, Indiana, Smith acquired his B. S. and Ch. E. degrees at Purdue and began his administrative career as plant metallurgist with International Harvester in Fort Wayne and Chicago. Prior to joining Tube Turns in January, 1943, as chief metallurgist, he was field metallurgist for Carnegie-Illinois. He is a member of the American Society of Metals, the American Society of Automotive Engineers, the American Welding Society and other technical bodies, and of two honorary fraternities, Tau Beta Pi and Phi Lambda Upsilon.

Elected vice presidents

G. G. Landis

H. F. Kneen

H. F. Kneen has been named vice president in charge of manufacturing, and G. G. Landis, vice president in charge of engineering for The Lincoln Electric Company, Cleveland, Ohio.

Kneen joined The Lincoln Electric in 1929, a few years after graduating from Cornell University where he received a master's degree, industrial engineering.

Promoted from his original position of assistant plant superintendent to general plant superintendent in 1931, Kneen has been largely responsible for carrying out the policies of the widely-known incentive plan instituted by the company's president, J. F. Lincoln, more than a decade ago.

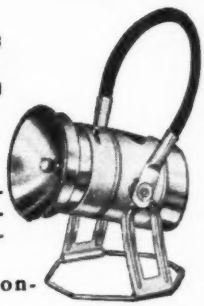
Landis is a veteran of more than 20 years with Lincoln Electric. He received his electrical engineering education at Ohio State University and graduated with a bachelor of science degree, 1922.

After two years with several large electrical companies, he resigned to enter the laboratories of Lincoln Electric in 1924, and was promoted to chief engineer in 1930. Many patents on both arc welding and electric motors have resulted from his genius.

You're "Safe"
When You Carry 90-UL ECOLITE

Don't wait — get this new Safety Lantern with BROKEN BULB EJECTOR!

SAFE in Hazardous Places



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Tested and Recommended by Underwriters' Laboratories.

- Sealed beam construction.
- Throws bright beam 1500 feet.
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Have you tried Rectorseal Recently?

Improvements developed to meet the severe requirements of the Armed Services has furthered the sealing qualities of RECTORSEAL. These laboratory tested and field proven refinements have been incorporated in the original formula which for seven years has been preventing leaks in threaded, gasketed and coupled connections for the Oil Industry.
If you haven't tried RECTORSEAL recently, get a can today and use it on all connections. Ask for it by name at your supply store.

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RECTORSEAL
THE POSITIVE LEAK PREVENTER

To sales staff

Edward A. Reineck has joined the technical sales staff of the Chemicals Department of The Quaker Oats Company, Chicago, Illinois. He will assist in the development of new applications for Furfural and its derivatives in the resins and plastics industry.

E. A. Reineck

Reineck was graduated from Lawrence College, Appleton, Wisconsin, in 1936. He has been on the staff of The Institute of Paper Chemistry for the last 9 years, engaged in research and application studies of Furan and other resins as finishes, molding powder binders, laminating varnishes, and adhesives.

S. M. Jones appointments

The appointment of W. E. "Bill" Barfield as Tulsa district representative of the S. M. Jones Company has been announced by L. J. Pundt, sales manager. Barfield succeeds W. M. Ware who has

W. E. Barfield

W. M. Ware

been transferred to Shreveport as district representative in northern Louisiana, Arkansas, Mississippi, and Alabama.

Barfield joins the Jones organization from Sinclair Prairie Oil Company where he was safety engineer. He was formerly in the purchasing department of both British American Oil Company and the Stanolind Oil and Gas Company.

Bill Ware, who has been with the Jones company for some time, formerly was with The Texas Pipe Line Company and an industrial engineering firm in Chicago. He studied engineering at the University of Tennessee.

Manager at Philadelphia

American Meter Company has announced that William G. Hamilton, Jr., was promoted from assistant manager to manager of the company's Philadelphia factory.

He joined American Meter Company in 1927, engaging in factory production until 1937, when he was advanced to engineering and sales activities, particularly in the fields of pressure regulation, flow measurement, and flow control. He added the duties of assistant manager in 1941. During the war he has been in charge of Philadelphia factory operations as acting manager, including extensive war production for which two "E" awards have been won, while Colonel R. W. McClenahan, the former manager, was on leave of absence.

Colonel McClenahan will return to the company as soon as his discharge in the near future becomes effective.

BJ vice president

Lynn Sawyer, general manager of the pump division of the Byron Jackson Company, was elected a vice president of the company at the October meeting of the board of directors, according to an announcement by E. S. Dulin, president.

Sawyer, formerly chief engineer of the Roosevelt Water Conservation District in Southern Arizona, entered the employ of Byron Jackson Company on June 1, 1929, as a local salesman in the San Francisco Bay area. He was made manager of the Mid-Continent division at Fort Worth in 1933, manager of the New York office in 1938, and in November, 1943, was recalled to the head office and promoted to general manager of the pump division. He enjoys an unusually wide acquaintance with pump engineers throughout the United States, Canada, Mexico, and in Europe.

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Bring your conference problems to The Mayo. Spacious, comfortable accommodations — private conference rooms, small or large auditoriums — convenient to business and industrial offices — are yours at The Mayo. And, as always, the finest food and best service.

Your request for reservations will be given immediate attention.

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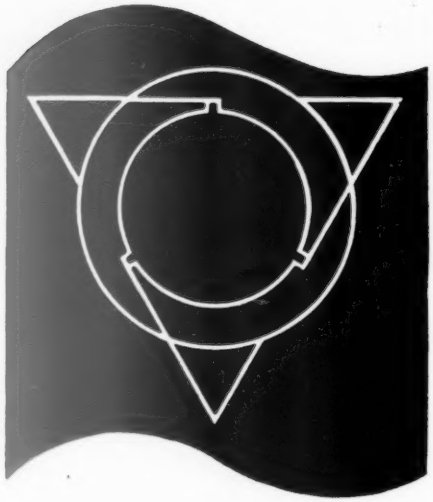

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ROD SCORING,
save power

"Full-floating" FRANCE rings in metal cases make a snug seal and compensate for rod deflection or misalignment—the ideal packing for piston rods and valve stems in any type of engine, pump or compressor. Wears as long as any other working part of the engine—saves power and prevents costly power shutdowns.

There is a time-tested FRANCE Packing design for steam, air, gas and crankcase oil service under any condition of speed, pressure or temperature. Recommended and used for years, the world over — Standard Packing of the Industry.

Write for Catalog M3

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Representatives in Principal Cities

Mid-Continent Oil and Gas Association division elects

Members of the Kansas-Oklahoma division of the Mid-Continent Oil and Gas Association met October 30. 1945, at the Tulsa Club in Tulsa. Oklahoma. and elected officers for the coming year. All officers of the organiz tion for the past year were re-elected with the exception of E. B. Shawver. vice president for Western Kansas. who asked to be relieved of further duty in office. H. E. Zoller of the Derby Oil Company. Wichita. Kansas. was elected to that office.

The members voted life memberships to Louis Campbell, retired head of Magnolia Petroleum Company land and production department at Oklahoma City, where he now resides, and D. B. Catterlin, retired after 36 years with Gulf Oil Corporation as assistant secretary. auditor, and head of the accounting department in the Tulsa. Oklahoma, division of that company. He now resides at Prairie Grove, Arkansas.

A resolution in memoriam was passed containing the names of members deceased since the last annual meeting. Those listed were: A. M. Corkle, Nelson K. Moody, James B. Diggs, Harry J. Brown, W. K. Holmes, B. P. Sibole, R. H. Mozier, P. J. Nealon, R. S. Ellison, J. R. Healy, and L. B. Jackson.

Re-elected officers of the Kansas-Oklahoma division of the Mid-Continent Oil and Gas Association. Left to right: President, Frank M. Porter, Fain-Porter Drilling Company, Oklahoma City, Oklahoma; first vice president, L. G. Owen, attorney-at-law, Tulsa, Oklahoma; vice president for Western Oklahoma, W. R. Wallace, Magnolia Petroleum Company, Oklahoma City, Oklahoma, and secretary-treasurer, Clarel B. Mapes, Mid-Continent Oil and Gas Association, Tulsa Building, Tulsa.

New and retiring president IPAA

Major B. A. Hardey (left), Shreveport, Louisiana, oil operator, was elected president of the Independent Petroleum Association of America at a recent meeting. The retiring president, Ralph T. Zook, is shown at right.

NPA announces meeting for April

Fayette B. Dow, general counsel of the National Petroleum Association, has announced that the semi-annual meeting of the association would be held at Hotel Cleveland, Cleveland, Ohio, on April 18 and 19, 1946. Arrangements are being completed for the meeting and an outstanding program is being arranged. Details of the program will be announced as soon as they are available.

Heads California Standard

The board of directors of the Standard Oil Company of California has elevated President H. D. Collier to the chairmanship of the board and elected R. G. Follis to the presidency.

R. G. Follis

Follis has been a vice president and director since 1942, and in December of last year was made assistant to the president.

A native of San Francisco and a graduate of Princeton, "Gwin" Follis first worked for Standard of California in 1924 at the Richmond refinery. After service both in Bakersfield and El Paso, he was transferred back to San Francisco in 1932, and in 1940 was made general manager of the manufacturing department.

New service

The Marsh Tritrol Company has broadened its activities and will now distribute the heating specialties distributed by Jas. P. Marsh Corporation along with the Marsh Tritrol regulator. To better describe the broadened operations, the firm name is being changed to Marsh Heating Equipment Company. Main offices are at 2122 Southport Avenue, Chicago. The organization is staffed by men well known in the heating industry. James Emmett, Jr., will head the staff as vice president in charge of sales.

James Emmett, Jr.

The consulting service of the organization comprises engineers equipped to give consultation on all phases of heating problems. Included are Roy Nelson, heating expert, and Fred Thuemling, who has specialized on heat control for many years.

Purchase completed

Acquisition of Security Engineering Company, Inc., of Whittier, California, by Dresser Industries, Inc., was officially completed November 1, with the issuance of Dresser common stock to the holders of Security common stock, H. N. Mallon, Dresser president, announced. The exchange was on the basis of 1 share of Dresser for 1¾ shares of Security.

Dresser's role as an organization serving all branches of the oil and gas industry from producing wells to final consumer is further strengthened by the addition of this company, which is widely known as a manufacturer of rock roller bits for sub-strata drilling operations. It also manufactures oil field tools, specialties, and a patented metal for oil-well liners.

This WISCONSIN-POWERED PUMP

Never "Looked Back" Once!

Here is a field gathering oil pumping unit that can "take it" . . . and keep on looking ahead for more! It consists of a Wisconsin VE-4 Air-Cooled Power Unit, direct-connected to a rotary pump through a Clutch Reduction. It handles 90 barrels per hour at 300 lbs. discharge pressure, operating in the South Hickory Creek field in Oklahoma . . . in the service of Stanolind Pipe Line Company.

This unit, at last report, had been operating almost a year out there in the open, in all weather! . . . without even the slightest adjustment on the engine!

You can't go wrong if your equipment is Wisconsin-powered.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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Oil field distributors for Wisconsin Engines and all types of utility units.

IS YOUR PRODUCTION GEARED TO SAFETY, TOO?
JUSTRITE

• Peak production for peace-time needs must be protected against the hazard of fire. Many accidental fires . . . caused by spontaneous combustion, stray sparks or improper containers are prevented systematically when Justrite Safety Products are on the job.

Justrite Safety Lanterns and Flashlights

The safety approved portable lights for oil fields, mines, chemical plants and many other hazardous locations. Listed by Underwriters' Laboratories, Inc., U.S. Bureau of Mines and Bureau of Marine Inspection and Navigation.

Model No. 44-S

Justrite Headlight that leaves both hands free. Battery case carried in pocket or clipped to belt. Has Safety Type "throw out" bulb socket.

The All-Purpose Safety Lantern that provides twin-bulbs with kick-out bulb sockets and sparkproofed guards for safety. Rugged, dependable and safe.

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Model No. 17-S

Handy-Safety Flashlight that has all the famous Justrite safety features sealed in a sturdy plastic case. A mighty midget flashlight with 1500 candlepower from 3 standard cells.

Justrite Safety Cans and Oily Waste Cans

Safety Gasoline Can

These cans are approved for safety by the Associated Factory Mutual Fire Insurance Companies and labeled by the Underwriters' Laboratories, Inc. The Safety Gasoline Can is safe for handling and storing flammable liquids. Sizes from 1 pint to 5 gallons.

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Oily Waste Can

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LINE SCALES

10 of the 20 Models we manufacture. 40,000 pounds to 500,000 pounds. A special scale for any job.

With a Line Scale you know the pull on the line, and the weight on the bit in pounds. Accurate, sensitive, rugged and economical.

Line Scales are dependable, even in areas of rapid temperature changes. Repeated tests prove the accuracy of Line Scale readings under all working conditions.

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Phone 2-1765, 907-11 SE. 29th Street, Box 4245
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"Best Bet Yet"

These oil-proof, wear-resistant, plastic tubing protectors are an integral part of the tubing collar. Made in all sizes, they prevent the metal-to-metal contact that has caused many expensive "wet" jobs in pumping wells in the past.

PATTERSON-BALLAGH TUBING PROTECTORS

LOS ANGELES 1 • HOUSTON 10 • NEW YORK 6

Heads Tube Turns

George O. Boomer, longtime associate of the late Walter H. Girdler, Sr., founder of Tube Turns, Inc., Louisville, Kentucky, was elected president of the firm at a recent meeting of the board of directors. He was vice president of Tube Turns when Girdler died unexpectedly last January.

George O. Boomer

Boomer succeeds Rudy E. Fritsch, who resigned early in October. Fritsch will remain with Tube Turns as a consultant, for the present.

Returns to industry

The return to the private heating industry of Henry S. Norris, until recently head of the Heating Branch of the War Production Board, has been announced by W. T. (Frosty) Winter, president of Consolidated Industries, Inc., Lafayette, Indiana. Norris has been appointed vice president of Consolidated and will be in charge of sales administration. Norris will work directly with the many hundreds of Consolidated dealers in every section of America.

Henry S. Norris

Norris, a native of Frederick County, Maryland, and a graduate of Princeton University, has had a long and rich experience in the heating field. Until 1929 he was associated with the American Radiator Company in New York, the Installation Engineering Company, and the M. E. Conran Company, Inc. In 1929 he formed his own firm, the Nassau Engineering Company, and represented the Iron Fireman Company and the Carrier Corporation.

Personnel changes

Ray A. Hancock, on military leave since April 20, 1941, has returned to resume his former position as California division operating superintendent, and Keith Miner has been appointed California division sales manager, according to an announcement by James W. McPhee, California division manager of Lane-Wells Company.

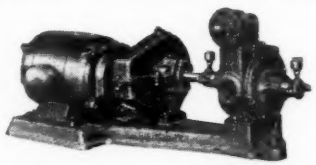
Hancock, a Lieutenant Commander, USNR, first joined Lane-Wells in 1938. He served in naval communications in the Marshall Islands and later Pearl Harbor.

Miner has been with Lane-Wells since 1937 and has been serving in several field capacities including that of California operating superintendent.

PUMPS for the PETROLEUM INDUSTRY

Write for Bulletin No. 102
which shows why and how

BLACKMER PUMPS
are SELF-ADJUSTING FOR WEAR



Gathering Pumps • Refinery Pumps
Bulk Station and Truck Pumps
Hand Pumps • Suction Line Strainers
Capacities to 750 GPM—Pressures to 500 psi.

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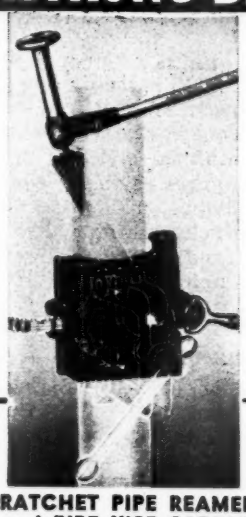
SERVING THE PETROLEUM INDUSTRY FOR 40 YEARS

Look for the Arm-and-Hammer
ARMSTRONG BROS.



RATCHET PIPE REAMER and PIPE VISE SADDLE

Use an ARMSTRONG BROS. Ratchet Pipe Reamer to assure full capacity, trouble-free pipe work. Its spiral fluted reamer quickly eliminates all inside burrs for it is milled, ground and hardened. Its drop-forged reversible ratchet operates in the closest quarters—only a 12½-degree handle swing required. Will give lifetime service.

The ARMSTRONG BROS. Pipe Vise Saddle brings the vise to the point of work. Attaches instantly to any pillar or post and provides a secure base (and pipe or conduit bender) for either hinged, chain or open side pipe vises.

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ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
321 N. FRANCISCO AVE CHICAGO, U.S.A.
Eastern Warehouse & Sales: 199 Lafayette St., New York

Standard promotions

Charles E. Finney, Jr., has been elected by the board of directors of Standard of California to the position of assistant vice president, manufacturing.

At the same time, Francis H. Smith was named general manager of the manufacturing department, in charge of operations and process planning and control, and A. C. Moorhead was appointed personnel director of the manufacturing department.

C. E. Finney, Jr.

Finney, a graduate of Cornell University with a degree in mechanical engineering, joined Standard in 1919 at the company's Richmond, California, refinery. In 1928 he was appointed assistant superintendent of the refinery, and subsequently manager of the pressure distillation department there.

In 1931 Finney went to El Paso, Texas, as manager of the Pasotex refinery, operated by a subsidiary company. Two years later he returned to California as manager of the Richmond plant. In 1933 he was transferred to the company's head office in San Francisco where he became successively chairman of the manufacturing committee, assistant general manager of the manufacturing department, and in 1943, general manager of the department.

Smith began working for Standard in 1913 at the El Segundo, California, refinery. Fifteen years later he was transferred to the Richmond refinery as superintendent, and in 1934 became manager of this refinery. In 1944 he was named assistant general manager of manufacturing, with headquarters in San Francisco.

Moorhead, a graduate of the University of California in mechanical engineering, was employed by Standard in 1917 at the Richmond, California, refinery. In 1943 he was appointed assistant general manager of the manufacturing department.

F. H. Smith

A. C. Moorhead

Foxboro adds Tivy

The Foxboro Company, maker of industrial instruments for measurement and control, announces the appointment of V. V. St. L. Tivy, as assistant manager of its oil and gas industries sales division.

ELECTRONIC AC VOLTMETER

with Logarithmic Scale

Percentage Accuracy of reading is uniform over entire scale!

ACCESSORIES

MODEL 220 DECADE AMPLIFIER

MODEL 402 MULTIPLIER

Since its development in 1935 the Ballantine Electronic AC Voltmeter is the only instrument of its kind with a Simplified Logarithmic Scale.

The important feature of logarithmic scale indication in the Ballantine Voltmeter provides the same degree of accuracy at 1 as at 10. Also the simplicity of this scale reduces errors in visual observation, common with most multirange instruments. Finally, the care taken in overall calibration combined with the inherent stability of the circuits used permits reliable readings within the 2% specified tolerance over the complete range of operation.

Write for descriptive technical Bulletin 8

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.

DURAMETALLIC
HANDY-PACK

★ HERE IS A CONVENIENTLY PACKAGED general-purpose packing that will come in very handy for meeting many sealing conditions in and around your plant. Designed for pump and valve stuffing box conditions on temperatures up to 450° F.

RECOMMENDED USES:

SATURATED STEAM	WATER, Hot or Cold
REFINERY FLUIDS, such as crude oil, fuel oil, gasoline, and the like.	DILUTE ACIDS
	BRINE
LUBRICATING OIL	DILUTE CAUSTIC
ILLUMINATING GAS	AMMONIA & ALKALIES

DESCRIPTION:

HANDY-PACK consists of two outstanding types of Durametallic spiral packing . . . ready to cut into the desired number of rings for packing stuffing boxes.

(1) DURAMETALLIC — A twisted, flexible, lubricated metallic packing (lead foil wrapped) to be used as end rings and on each side of lantern gland.

(2) DURA-PLASTIC — A resilient, lubricated, semi-metallic packing to be used between the DURAMETALLIC packing rings.

WRITE FOR BULLETIN NUMBER 156P COVERING HANDY-PACK SIZES AND PRICES

DURAMETALLIC CORPORATION
The PERFECT SEAL
KALAMAZOO MICHIGAN

Joins UOP research staff

R. M. Deanesley, recently with M. W. Kellogg Company and Kellex Corporation, has joined the research staff of Universal Oil Products Company. He will be in charge of a new department that is being established in the company's Riverside laboratories.

Born in England and educated at Oxford and at University College, London, Deanesley has had extensive experience in the petroleum industry, especially in the light hydrocarbon field, having been associated with Shell Development Company for 15 years before joining the Kellogg organization.

His activities have included work on production of isooctane, catalytic polymerization of olefins, and other catalytic processes related to the production of aviation gasoline; also development of processes for the chlorination, sulfation and hydration of hydrocarbons, and azeotropic rectification. His inventions have brought him a number of patents.

Reilly makes gift to university

Notre Dame University has announced a gift of $1,000,000 from Peter C. Reilly, president of Reilly Tar and Chemical Corporation and Republic Creosoting Company, of Indianapolis, Indiana. The contribution, largest single gift in the history of the university, is to be known as the P. C. Reilly science fund, and will be an endowment.

Reilly specified that the income from the endowment is to be used in the field of chemistry and chemical engineering. Awards specified include an annual fellowship to the outstanding lay members of the graduating class in chemistry or chemical engineering departments of Notre Dame, four annual graduate non-teaching fellowships of $1000 each for graduates of chemistry or chemical engineering from Notre Dame or schools other than Notre Dame, and an honorarium of $5000 annually to an outstanding chemist or chemical engineer for a one-semester series of lectures at the university.

At the end of eight years the number of annual graduate non-teaching fellowship is to be increased as the income from the fund increases. In the fiftieth year of the fund the income from the accumulated capital fund shall be divided equally, 50 per cent to be used for fellowships and lectures and 50 per cent to be added to the capital fund.

Reilly, who has been a member of Notre Dame board of lay trustees since 1934, is a pioneer in the development of the American coal tar industry. In 1886 he became associated with the Mica Roofing Company in New York City. This firm, one of the original coal tar distillers in the United States, was succeeded by the Western Chemical Company in Indianapolis, and Reilly was sent there to manage the business. In 1900 he opened his own business in Indianapolis, under the name of the Western Chemical Company, which was subsequently reorganized as the Republic Creosoting Company. In 1932 he purchased the International Combustion Tar and Chemical Company, which operated plants in several states, and which are now a part of the Reilly Tar and Chemical Corporation.

Advertising manager

Young Radiator Company, Racine, Wisconsin, has appointed William J. Schlapman advertising and sales promotion manager. He has been associated with the company for a number of years.

Schlapman is a member of the Society of Automotive Engineers and was recently elected state president of the Wisconsin Junior Chamber of Commerce.

Purchases instrument firm

American Chain and Cable Company, Inc., Bridgeport, Connecticut, has acquired the business of the Certified Gauge and Instrument Corporation, of Long Island City, New York. The principal product of the latter company is a pressure gage with a new patented mechanism called the Helicoid movement. This gage was developed during the war and is used widely by the Army and Navy. Manufacturing will continue at the Long Island City plant under the name Helicoid Gage Division, American Chain and Cable Company, Inc. As Helicoid gages are used in the same general fields as two of American Chain and Cable's present lines, Reading-Pratt and Cady valves and d'Este automatic regulating valves, the acquisition of this new line will supplement the company's products for markets it now serves.

Failing sales engineer

J. C. Failing has assumed the duties of sales engineer for the George E. Failing Supply Company, Enid, Oklahoma, and Houston, Texas, manufacturers of exploration and drilling equipment.

J. C. Failing

He is well known among the oil fraternity of the southwest having been associated with his father in the manufacture of drilling equipment since the company was organized. During the war he served with the Seabees, seeing action on several islands of the Pacific and being with the first group of Seabees to land on Guadalcanal.

The Failing Supply Company is making plans to open two branch stores to serve the oil industry, one of them to be in a West Texas city and the other either in Mississippi or Alabama. Parts now are being assembled at the main plant in Enid to supply the two new stores. As a further service to the oil industry several field representatives are being added to the Failing organization.

ASTM meetings

The executive committee of the American Society for Testing Materials has just confirmed an earlier decision to hold the 49th annual meeting of the society in Buffalo from June 24 to 28, 1946, and in conjunction therewith to have the Seventh Exhibit of Testing Apparatus and Related Equipment.

The 1946 spring meeting of the society will be held in Pittsburgh during the week of February 25 to March 1. This week will also be ASTM Committee Week during which there will be many meetings of ASTM technical committees.

Further announcements will be made concerning the technical features of both the annual and spring meetings. Several extensive symposiums are being developed and there will be a large number of technical papers and committee reports.

Federated appoints Max Robbins

Edgar L. Newhouse, Jr., president of Federated Metals Division, American Smelting and Refining Company, announced the appointment of Max Robbins as general manager of Federated with headquarters at 120 Broadway, New York City.

Max Robbins

Robbins has been associated with Federated since 1936. During that time he has held the position of manager of the Federated Chicago plant, manager at Whiting, Indiana, and subsequently, general manager of the company's midwestern department consisting of the Whiting, St. Louis, Detroit, and Pittsburgh branches.

With a background of many years experience in the smelting and refining industry, Robbins is well equipped to participate in the administration of Federated's activities.

Installs new machinery

Link-Belt Company, in order to expedite delivery of cut tooth sprockets to the oil country, has recently installed a Newark No. 7 automatic gear cutting machine in its Dallas plant, 500 South Latimer Street, Dallas, Texas.

This new machine will cut up to 100-in. diam. No. 4 API steel sprockets, and up to 100-in. diam. by 24-in. face, 1-DP., steel spur gears.

A complete line of cutters for API Nos. 3, 4 and SS-3125 and Manufacturers' (ASA) Standard sizes of roller chain sprockets, also cutters for 14½ degree pressure angle spur gears, have been bought and are ready for service.

Link-Belt's Dallas plant is equipped with the necessary turning, boring and keyseating equipment to handle large sprockets and gears.

Complete stocks of Manufacturers' (ASA) standard and special oil field sizes of roller chain are regularly carried in the Dallas warehouse.

Remove Packings this EASIER way

Use DURA HOOKS

Sturdy ALL STEEL Packing Pullers

HERE is a time saving device for removing old packing from stuffing boxes that will improve your manpower efficiency. DURA HOOKS are rugged, flexible hand-tools that can be used in "hard-to-get-at" places. For best results use two hooks as shown in illustration. Order your requirements today . . .

DURA HOOKS — HANDY SETS

Set No.	Description	Price
Set AA	Consists of 3 pairs of hooks, 7½", 11" & 15" in length. For use in packing spaces ¼" to ½" incl.	$ 8.00
Set BB	Consists of 4 pairs of hooks, 7½", 11", 15" & 19" in length. For use in packing spaces ¼" to ⅝" incl.	13.60
Set CC	Consists of 5 pairs of hooks, 7½", 11", 15", 19" & 22" in length. For use in packing spaces ¼" to 1" incl.	20.00
Set DD	Consists of 6 pairs of hooks, 7½", 11", 15", 19", 22" & 30" in length. For use in packing spaces ¼" to all over 1 inch.	29.60

ABOVE PRICES U.S. ONLY . . . ASK YOUR JOBBER OR ORDER DIRECT FROM FACTORY . . . BE SURE TO INCLUDE YOUR PRIORITY

DURAMETALLIC CORPORATION — The PERFECT SEAL

KALAMAZOO MICHIGAN

General sales manager

Appointment of Robert G. Allen as general sales manager of The Baldwin Locomotive Works, effective November 1, has been announced by Ralph Kelly, president.

Allen was born in Winchester, Massachusetts, and received his education at Phillips Andover Academy and Harvard University. In 1925 he became associated with the Walworth Company holding the post of division sales manager from 1929 until 1936. From 1936 to 1940 he served two terms as representative from the 28th Pennsylvania district, in the Congress of the United States, during which time he occupied a place on the Foreign Affairs Committee.

Allen was elected president of the Duff-Norton Manufacturing Company in 1940, which position he held until July, 1942, at which time he was granted a leave of absence to accept a commission as major in the United States Army, Ordnance Department. He served as chief of Tank Branch and later executive officer of Philadelphia Ordnance District. In February, 1943, he was promoted to the rank of lieutenant colonel, and a few months later was transferred to field service and sent overseas where he served as battalion and group commander.

In March, 1945, Allen joined the Baldwin organization as general manager of Baldwin Southwark Division of the company, which position he held until his recent appointment.

War leaders in portrait and sketch

"The Generals and the Admirals" is the title of a book published by The Devin-Adair Company. The book contains biographies and portraits of some of the leaders of United States armed forces in World War II. The biographies were written by editors of *Newsweek*, but of especial interest to members of the petroleum industry is the fact that the portraits were drawn by T. H. Chamberlain of the American Flange and Manufacturing Company, Inc., of New York City.

Editorial service changes

The following changes in its editorial service have been made by the Westinghouse Electric Corporation.

Hendley Blackmon has resigned as manager of editorial service to join the McGraw Hill Publishing Company as electrical editor of product engineering. Pending the return of Lt. Carl Nagle, now on duty in the Pacific with the U. S. Navy, H. C. McDaniel will act as supervisor of editorial service and be responsible for the company's technical and trade magazine publicity activities.

Blackmon has been associated with Westinghouse since his graduation from Georgia School of Technology in 1925 as an electrical engineer. After service as an engineer in switchboard engineering department and in general engineering department, in 1932 he was named technical editor of the company's technical press bureau and since 1938 he has been manager of Westinghouse Editorial Service. In his new position, Blackmon will be in the McGraw-Hill Building, New York City.

McDaniel, a native of Oregon, was graduated from Oregon State College in 1926 with a B. S. in electrical engineering. After 8 years with the Pacific Power and Light Company and 5 years with the Central Illinois Public Service Company, he joined the Westinghouse lamp division in 1939. McDaniel has been a member of the staff of editorial service since 1943.

After graduating from Stanford University in engineering and economics in 1937, Lt. Nagle worked successively for James McCreery Company, Montgomery Ward and Company, and the Champlain division of the Interchemical Corporation. Lt. Nagle joined Westinghouse editorial service in 1941 and he was granted a leave of absence in 1943 to enter the Navy.

Gas association officers

The executive committee of the newly organized Independent Natural Gas Association of California has elected the following officers: David T. Staples of Pacific Western Oil Corporation, president; H. A. Eklund of British American Oil Producing Company, vice president; Rush M. Boldget of Blackfoot Petroleum Company, secretary-treasurer, and A. E. Bell, Jr., of A. E. Bell Corporation, assistant secretary-treasurer.

General Petroleum appointments

Transfers and advancements of seven petroleum geologists and engineers of the General Petroleum Corporation organization in California are announced by C. M. Wagner, manager of the geological department.

C. J. Dean, senior petroleum engineer since 1941 and with the corporation since 1923, has been transferred to Socony-Vacuum Company, C. A., Venezuela, as chief petroleum engineer, production department, with headquarters at Caracas. Aside from being well known in petroleum and geological circles, Dean is well remembered in California and elsewhere as a tackle on the "Wonder Team" of University of California.

R. O. Swayze, assistant manager of the geological department, is transferred to the production department and made assistant manager of the Rocky Mountain division. He has been with General Petroleum since 1921.

J. C. Kimble, senior geologist, who has been with the corporation since 1935, is appointed assistant manager (exploration) of California district.

E. L. DeMaris, chief petroleum engineer is advanced to assistant manager (exploitation) of California district. He has been with the corporation since 1923.

F. L. Wadsworth, petroleum engineer who joined the organization in 1935, becomes chief petroleum engineer of California district.

E. J. Coenen, petroleum engineer with the company since 1935, is made petroleum engineer for the San Joaquin Valley division.

A. P. Bowie, assistant petroleum engineer employed in 1944, is appointed petroleum engineer for the east side of the San Joaquin Valley division.

Receives Perkin medal

Dr. Francis C. Frary, director of research of Aluminum Company of America, has been elected to receive the Perkin Medal in recognition of his outstanding accomplishments in the field of industrial research, it is announced by Cyril S. Kimball, secretary of the American Section of the Society of Chemical Industry. The presentation of the medal will take place at a dinner meeting of the society at the Hotel Commodore on the evening of January 11, 1946.

Dr. Frary is the fortieth member of a group of distinguished scientists to receive the Perkin Medal. He is also the second scientist on the staff of Aluminum Company of America to be so honored. In 1911, Charles Martin Hall was awarded this coveted medal for his development of the present day process for the manufacture of aluminum.

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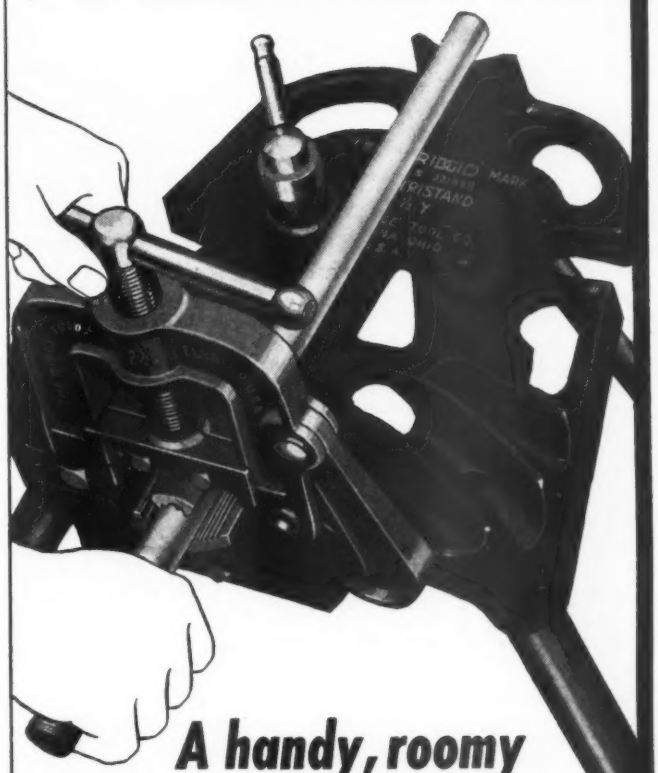
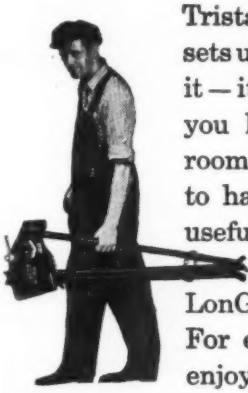
RIDGID

Portable Tristand Vise



A handy, roomy workbench easily set up anywhere



• It isn't so much how handily the Tristand folds up, carries easily and sets up solidly exactly where you need it — it's the workbench convenience you like most. Look now — lots of room for dope pot and oil cans, slots to hang tools, a pipe rest and 3 very useful benders. And whether yoke or chain vise, you get tool-steel LonGrip jaws, easy on polished pipe. For easier work, convenience you'll enjoy — buy it at your Supply House.

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WORK-SAVER PIPE TOOLS

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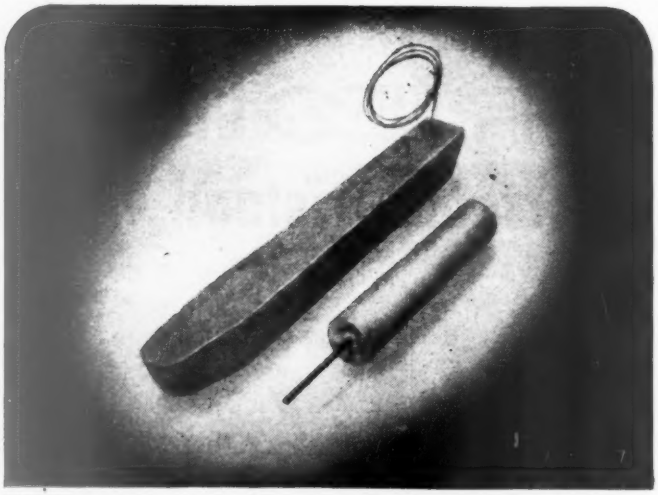

Magnesium Anodes for Cathodic Protection

Corrosion of pipelines and other buried metal structures may be greatly retarded by use of Magnesium Anodes. When properly installed—taking into account variations in soil conditions, location and frequency of anodes—Magnesium Anodes can provide maximum protection with attractive cost advantages. Federated magnesium alloy anodes with cast-in iron lead wires are available in two shapes—

4" diameter x 18" long—weight about 12#
4¼" x 4¼" x 3' long—weight about 40#

(Can be made in other shapes to suit your requirements—write for further information.)

FMD *Federated*
METALS DIVISION
AMERICAN SMELTING and REFINING COMPANY
120 BROADWAY, NEW YORK (5) N. Y.
Nation-wide service with offices in principal cities

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American Roller Bearing president

William G. Succop, son of the late Clarence F. Succop, has been named to succeed his father as president of American Roller Bearing Company, Malwood Street, Pittsburgh, Pennsylvania. Succop has been associated with the company for some years in sales and administrative capacities. Carl Knaak, long general manager of the company, retains that position and in addition has been elected executive vice president.

Joins firm

Dr. A. G. Loomis is now associated with Keplinger and Wanenmacher, consulting petroleum engineers, Tulsa, Oklahoma. During the last 10 years Dr. Loomis has been in charge of research in production and drilling problems for Shell Development Company at Emeryville, California, and prior to that conducted research for the Gulf Oil Company. He has had considerable experience in pressure maintenance, production problems, PVT analysis, core analysis, drilling muds, and numerous problems involving the chemistry and physics of oil and gas.

In view of Dr. Loomis' training and experience, his advice on equipment and technique should be of considerable value to those who are about to install or expand laboratories for research in production and drilling problems. His intimate knowledge of research in various production problems will enable him to render assistance to companies and operators who encounter such problems but have limited facilities for solving them.

Offices will be maintained in California at 85 Parnassus Road, Berkeley 8, telephone 7213.

Duling appointed by Cummins

Cummins Engine Company, Inc., Columbus, Indiana, manufacturers of diesel engines for automotive, industrial and marine applications, has announced the appointment of Byron A. Duling as manager of the Cleveland region. Offices for the region, which includes Ohio, Michigan, and a part of Pennsylvania, are at 805 Fidelity Building, Cleveland 14, Ohio.

B. A. Duling

Duling succeeds Fred W. Sparks, who has been appointed sales manager of manufacturing accounts for Cummins.

Duling has been affiliated with Cummins for 9 years in various engineering and sales engineering capacities, and is thoroughly familiar with all types of diesel engine applications. For the last 3 years he has been a sales engineer. He is widely acquainted among the manufacturers of industrial and automatic equipment, many of whom are in the Cleveland area.

A native of Bloomington, Indiana, Duling is married and has 4 children. He expects to move his family to Cleveland soon.

Lucas medal to J. O. Lewis

At a meeting of the board of directors of the American Institute of Mining and Metallurgical Engineers, held at the headquarters of the Institute in the Engineering Societies Building, 29 West 39th Street, New York, New York, James Ogier Lewis was by unanimous vote awarded the Anthony F. Lucas Gold Medal for 1946. The award was recommended by the Lucas Petroleum Medal Committee, of which J. B. Umpleby, petroleum engineer of Dallas, Texas, is chairman. The medal recognizes "distinguished achievement in improving the technique and practice in finding and producing petroleum."

J. O. Lewis

The medal will be presented to Lewis at the annual meeting of the Institute, which will be held at the Palmer House, Chicago, February 25-28, 1946.

The Anthony F. Lucas Medal was established in April, 1936. It has been presented in the past to such distinguished members of the AIME as, J. Edgar Pew, 1937; Henry Latham Doherty, 1939; E. De Golyer, 1940; Conrad and Marcel Schlumberger, 1941; John Robert Suman, 1943; Charles Van Ormer Millikan, 1944.

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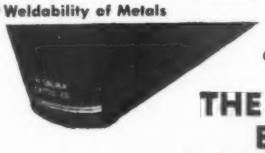

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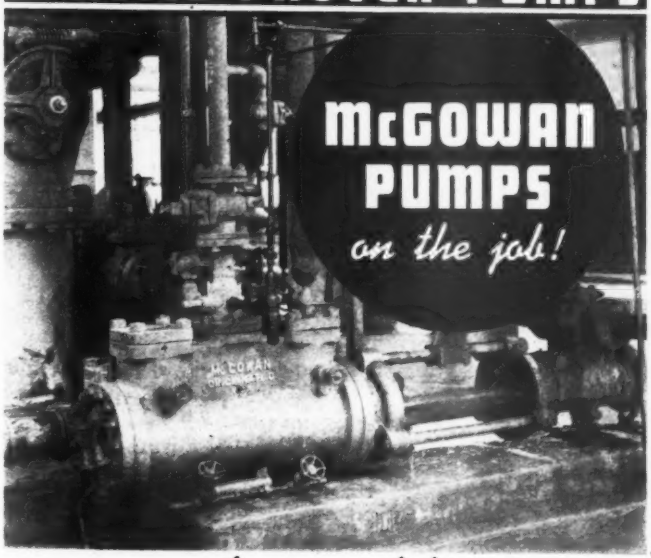

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Bucyrus-Erie distributor

Appointment of The Straker Supply, Mt. Pleasant, Michigan, as distributor for Bucyrus-Erie oil well spudders was announced recently by Bucyrus-Erie Company, South Milwaukee, Wisconsin.

Long known in Michigan drilling and production circles, The Straker Supply will handle the complete Bucyrus-Erie spudder line in a territory covering the entire lower peninsula of Michigan. Service to this territory will be maintained through the Mt. Pleasant office and shop.

New construction firm

Currently announced at its San Francisco headquarters is the formation of Bechtel Brothers McCone Company, a new corporation in the engineering and construction business.

Executives and key personnel have been drawn from the Bechtel and the Bechtel-McCone interests, extensively identified with major construction on the Pacific Coast principally, but also embracing a number of projects in Alaska, Canada, the Caribbean area, the Persian Gulf, and the Philippines. The board of directors consists of S. D. Bechtel, John A. McCone, K. K. Bechtel, John L. Simpson; W. E. Waste, president; J. P. Yates and Van W. Rosendahl, executive vice presidents; Jerome K. Doolan and V. G. Hindmarsh, vice presidents.

W. E. Waste, president, and former vice president and general manager of Marinship Corporation, defines the Bechtel Brothers McCone Company enterprise as "an engineering and construction service for industrials and government bodies, placing special emphasis on work required by the petroleum, mining, chemical, and other heavy process industries; railroads, public utilities, and government authorities."

The principals of the organization have managed the design and construction of a substantial volume of private and public works, including oil refineries, oil, gas and water pipe lines, pumping systems, chemical plants, food process plants, mines and ore reduction plants, railroads, ports and terminals, power plants and electrical distribution systems, industrial housing and office buildings, shipyards, shipbuilding and repair, bridges, tunnels, dams and highways.

The Bechtel and Bechtel McCone interests have also administered and operated aircraft modification and automotive equipment reconditioning plants, harbor facilities and port systems.

Sales engineers in branches

In order to give better and quicker service to the greatly increased number of users of the SR-4 strain gage, the Southwark Division of the Baldwin Locomotive Works has placed field sales engineers in five of the company's branch offices. These engineers are specialists in the use and applications of the SR-4 and can be called upon by any user or prospective user of the gage. The men and their offices are: Richard Hannon, Boston; Joseph Farley, Chicago; Robert Cleeland, New York; Glenn Rowell, Philadelphia, and Stanley Zansitis, Detroit. Jordan H. Gaul is SR-4 sales manager at the Eddystone, Pennsylvania, office.

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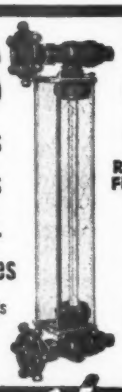

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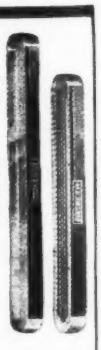

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L. H. True made vice president

The election of L. H. True as vice president of Magnolia Pipe Line Company has been announced by D. A. Little, president.

More than half of True's lifetime has been spent in the service of the company. Born in Belton, Texas, in 1903, his first work was done during vacation time in 1921. December, 1922, marked his regular employment, first as time keeper and material man in Arkansas and Oklahoma. Promoted to gager at Corsicana during the Powell boom, he later was transferred to Archer, then to Crane, and next to Wink. In 1931 he was transferred to East Texas as chief gager and pipe line scout. From East Texas, True was promoted to superintendent of the Luling, Texas, district. In 1937 he was appointed general superintendent of Texas, Arkansas, and Louisiana. A year later he was named assistant manager of pipe lines and early in 1945 was elected a member of the board of directors of Magnolia Pipe Line Company. True was elected vice president October 29.

L. H. True

Retirement and insurance plans

As a further step toward closer cooperation of The M. W. Kellogg Company, petroleum engineers and equipment manufacturers, of Jersey City, New Jersey, and New York, with other subsidiaries of Pullman Inc., it is announced that the employe retirement and group insurance plans of the latter's manufacturing subsidiaries have been extended to include the permanent employes of the M. W. Kellogg Company. Both plans, already established for some years by Pullman, go into effect immediately for the Kellogg personnel. The retirement plan operates on a contributory basis, both Kellogg and the employes making joint payments.

The group insurance plan provides basic group life insurance purchased jointly by employe and company contributions and an additional group life insurance for these policy holders at the end of 6 months service, paid for solely by the company and continued after retirement until death. The plan also covers accidental and natural death, surgical expense, disability benefits due to non-occupational accident and sickness, and hospital expense for employes and their dependents. Both the retirement and group insurance plans are underwritten by Prudential Insurance Company.

Credit manager National Supply

John B. Mensing, assistant treasurer of The National Supply Company, has been appointed general credit manager replacing Dana J. Fox, who is resigning to become president of Fretz-Moon Tube Company.

Mensing has been in the credit and treasury departments of National for more than 25 years.

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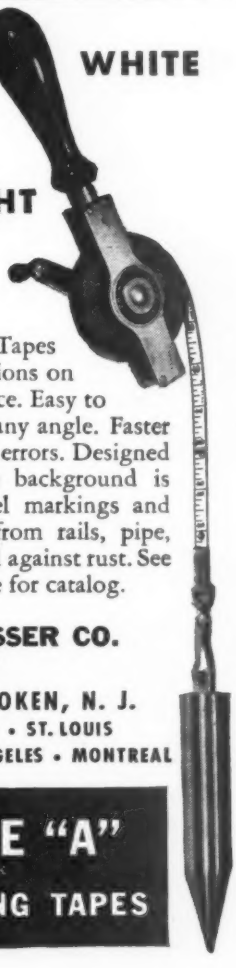

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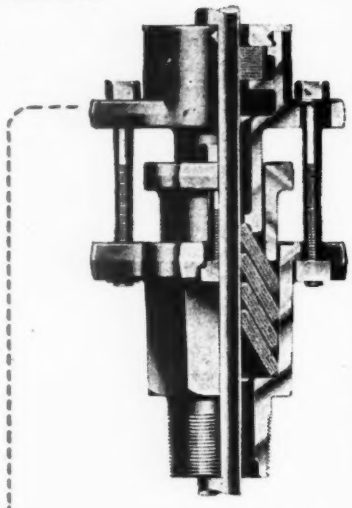

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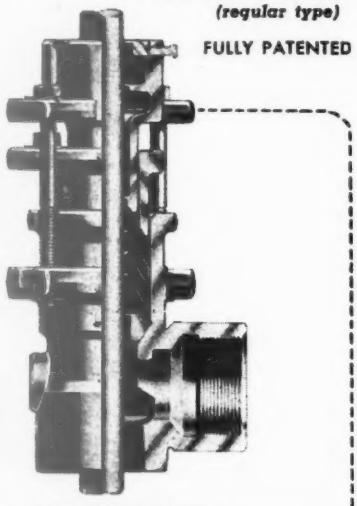

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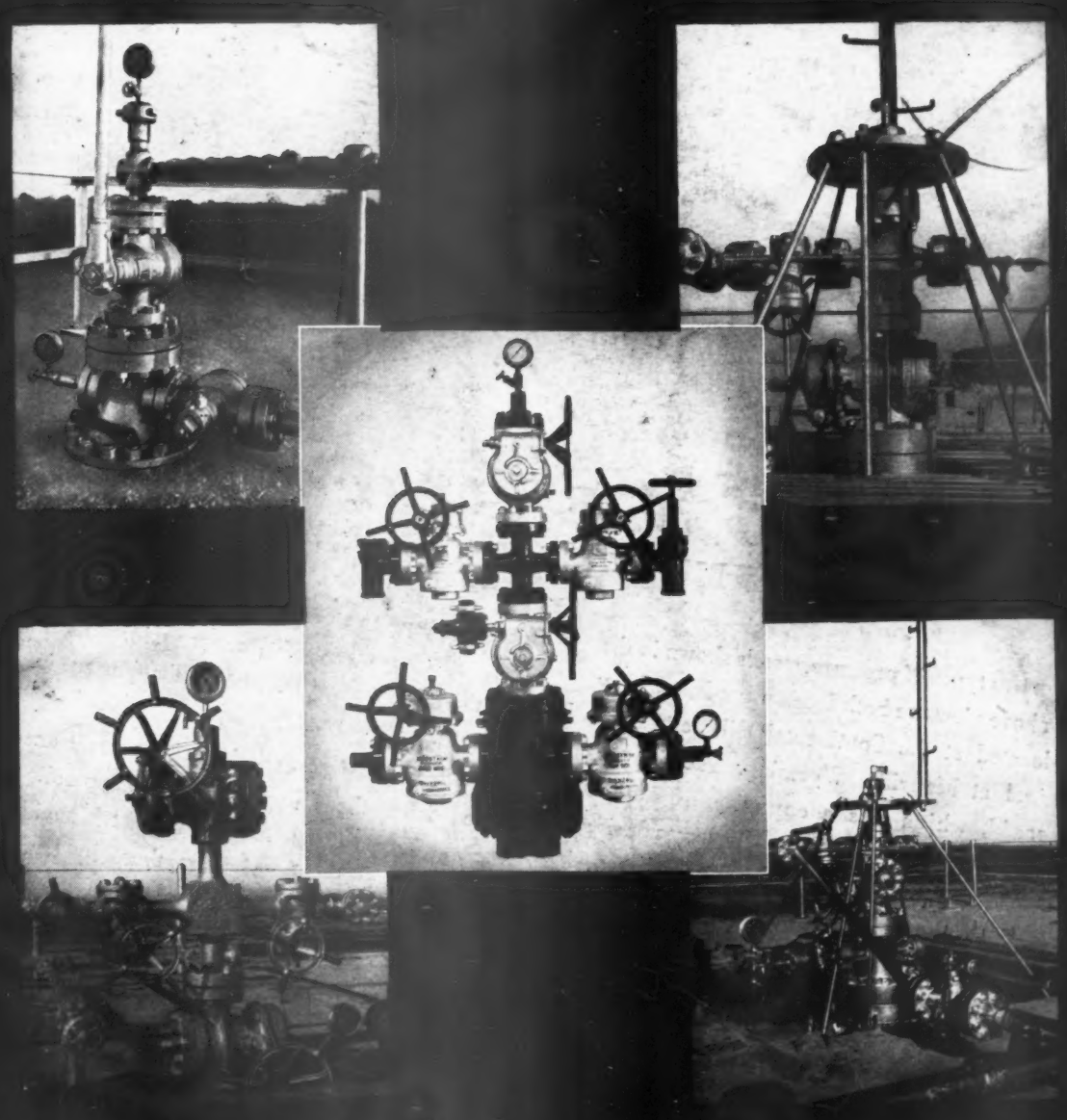
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